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EXAMINATION OF BEHAVIORAL MOMENTUM WITH STAFF AS CONTEXTUAL
VARIABLES IN APPLIED SETTINGS WITH CHILDREN WITH AUTISM

by

Mark P. Groskreutz

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Disability Disciplines
(Applied Behavior Analysis)

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ABSTRACT

Examination of Behavioral Momentum with Staff as Contextual Variables
in Applied Settings with Children with Autism

by

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Utah State University, 2010

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Department: Special Education and Rehabilitation

Behavioral momentum theory proposes that the persistence of behavior when exposed to disruptors provides an appropriate measure of the strength of behavior. Basic research has consistently demonstrated that behaviors that occurred in a context with higher overall rates of reinforcement (rich contexts) were more persistent than other behaviors that have occurred in a context with relatively lower rates of reinforcement (lean contexts). More surprisingly, behavioral momentum theory goes on to assert that this greater persistence in richer contexts is found even when rate of responding is lower in the rich context, and when the greater richness is due to noncontingent reinforcement or reinforcement for alternative responses. If behavioral momentum effects documented in laboratory settings are manifested in applied settings, these procedures may be used to increase the persistence of desirable behaviors or decrease the rate of problem behavior while simultaneously increasing its persistence. However, research on behavioral momentum has primarily been conducted by basic researchers using basic preparations. A key component of research on behavioral momentum is the presence of different contexts (typically signaled by color cues) each associated with a different rate of reinforcement. It is currently unclear if behavioral momentum effects are common in applied settings and if so, what variables determine context in applied settings. Thus, translational research should be

conducted to examine the extent to which behavioral momentum theory accurately predicts behavior in applied settings while making systematic extensions to the established basic procedures. The purpose of the current study was to make one such extension that may be particularly important for replication of behavioral momentum research in applied settings. Two therapists functioned as two contexts with each participant to examine the effects of two interventions (i.e., contingent reinforcement with or without additional noncontingent reinforcement). Across participants, different patterns of results were found. In addition, participant responding was only partially disrupted during extinction and distraction phases, suggesting the procedures did not arrange a strong test of behavioral momentum theory. Because extinction did not reduce responding to very low levels, tests of reinstatement do not allow for clear conclusions to be drawn. In addition, patterns of responding did not clearly indicate participants were discriminating contexts. Several potential reasons for the lack of strong effects are discussed and suggestions for follow-up research are presented.

(115 pages)

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CHAPTER I

INTRODUCTION

Behaviorism is the philosophical basis of two fields of scientific inquiry, the experimental analysis of behavior and applied behavior analysis. In each of these fields, professionals focus on the description, prediction, and influence of behavior of individual organisms. Organisms engage in specific responses (i.e., behaviors) as a result of a complex interaction between the organism's genetic endowment, current environmental conditions, and the organism's history of interactions with similar environments. Specifically, behavior is commonly examined and described relative to some environmental conditions present before the response (i.e., antecedents) and some changes in the environment that happen concurrently with or shortly after the response (i.e., consequences).

The experimental analysis of behavior focuses on increasing understanding of behavior (i.e., description, prediction, and influence) using highly controlled experimental settings and manipulations. Target behaviors in basic research often entail discrete and arbitrary behaviors (e.g., lever pressing, key pecking). By using highly controlled settings and discrete, arbitrary responses, researchers are able to make fine grained analyses of clearly-defined behaviors that would not be possible in applied settings. In an effort to control as many variables as possible, researchers commonly use animal subjects as basic models of human behavior. This experimental precision may allow identification of consistent, predictable, and experimentally controllable patterns in responding and, ultimately, principles of behavior. While these principles are often identified through basic research methods (i.e., highly controlled settings with animals), the outcomes are considered fundamentally related to human behavior and daily life and may lead to important applied research and practice. One goal of research in applied behavior analysis is to extend research from basic analyses to application of principles to improve the success of individuals by focusing on socially important behaviors. In contrast to the settings, subjects, and

arbitrary behaviors used in basic research, applied researchers typically identify and examine socially important behaviors and often conduct research in highly complex contexts relevant to participants and the behaviors of interest (Baer, Wolf, & Risley, 1968).

When basic research produces highly consistent results and there are important potential implications to applied practice, researchers should examine the generality of the findings using human participants, socially relevant behaviors and settings common in practice. In moving from basic to applied research, there is necessarily a translation process. Only through this translation will it become clear if the findings from basic research are in fact relevant to human behavior in natural settings. This process may occur along a continuum from research preparations that are essentially basic (e.g., including human participants while keeping all other procedures the same) to changing virtually all aspects of the research method (e.g., including human participants, socially important behaviors, contextually appropriate interventions, and complex environments). One advantage of initially making only small changes to basic procedures is that it may allow clearer connections to be drawn. By including small, systematic changes, the relations between the new findings and established findings may be more easily identified and inconsistencies clarified. Alternatively, if researchers make larger jumps in design or procedures, they may find interesting and useful results yet obscure functional similarities to the basic findings. As the number and size of methodological changes increase within a single translational study, it becomes progressively more difficult to ensure that the principles or phenomena being examined are the same ones identified in basic research. In other words, when basic research and applied studies are substantially different, direct and identifiable relations to basic methods and findings become tenuous. Ideally, the translational process focuses on clear, systematic replications, which ultimately reduces the likelihood of leaving gaps while working towards applied importance.

Response Strength

Basic and applied research on behavior may both be considered an effort to understand variables that effect response strength and ways to effectively manipulate these variables to change the strength of responses. Response strength is a construct and therefore cannot be directly measured. Instead, one or more dimensions of behavior must be measured to provide an index (or indicator) of response strength. No single aspect of behavior is inherently representative of response strength; researchers must make an argument that a particular dimension of behavior is an adequate indicator of response strength for a particular purpose. Skinner (1938) suggested that, "appeal must be made to frequency of occurrence in order to establish the notion of strength. The strength of an operant is proportional to its frequency of occurrence" (p. 21). Therefore, higher frequencies indicate stronger responses, and the unit of measure is typically expressed as frequency over a specific time period (i.e., rate). Researchers in the experimental analysis of behavior and applied behavior analysis have used measures of rate as the primary index of response strength, and this research has lead to many consistent and important findings. The conceptualization of rate as the predominant measure of response strength is evident in the fact that the majority of applied research studies measure rate of behavior as the primary dependent variable. In these studies, the assumption is that increasing or reducing the rate of a response is synonymous with increasing or reducing its strength.

While rate has been by far the most commonly used index of response strength, Skinner (1957) also noted that several other dimensions of behavior could provide evidence of response strength. He suggested that emission of a given response indicates response strength, and even greater strength is indicated when current conditions would be expected to suppress the response (e.g., talking during a test). Additionally, Skinner suggested other indicators of increased response strength: Greater energy level of a response; greater speed of response, both relative to some evocative stimulus (i.e., latency) or between successive responses (i.e., interresponse time);

and additional repetition of responses. While Skinner suggested that these dimensions could indicate response strength, he also noted that they were imperfect measures of response strength. As such, he noted that determinations of response strength, particularly in applied situations, require analysis across multiple variables. Thus different indicators may be more or less relevant when determining response strength in different situations.

Nevin (1974) has explored another conceptualization of response strength, *resistance to change*. A response is resistant to change (i.e., persistent) to the degree that it is unaffected by environmental changes that would be expected to disrupt the response. Nevin has suggested that more persistent responses have greater strength, and he has noted that greater persistence may actually be more similar to traditional notions of strengthening than increased response rates. In contrast to other indexes of response strength (i.e., rate, intensity, latency, interresponse time, and repetition) that attempt to measure strength of a response under a set of constant conditions, determining persistence requires measurement of responding under different conditions at two different points in time (i.e., measures of responding before and after some change). Interestingly, the pre- and post-change observations can measure several different dimensions of behavior, such as rate, intensity, latency, etc., because persistence is defined as the change in some dimension of a response.

In *Verbal Behavior*, Skinner (1957) wrote, "Under laboratory conditions probability of response is easily studied in an individual organism as frequency of responding. Under these conditions simple changes in frequency can be shown to be precise functions of specific variables, and such studies supply some of the most reliable facts about behavior now available" (p. 28). Rate of response was a particularly appropriate measure of response strength in Skinner's experiments. In these experiments, the effect of specific contingencies of reinforcement (e.g., schedules, magnitude, delay to reinforcement) on rate of one behavior could be measured and interpreted as an index of strength, because a given condition would be in place until stable rates

of responding were observed (see Skinner, 1953, Chapter 5 for a discussion of these arrangements). In contrast, rate of responding may be less useful as an indicator of response strength when conditions become more complex, such as with changing conditions and the presence of additional target responses (e.g., changes in contingencies with several response classes and multiple sources of contingent and noncontingent reinforcement).

Under changing conditions, rate of responding will be based on the current set of contingencies, but at a different point in time, contingencies will likely be different and therefore select different rates of responding. In these changing conditions, rate may be most useful as a measure of response strength when a given set of contingencies remain constant. As long as conditions remain constant, rate of responding appears to be a useful index of response strength and facilitate accurate predictions of levels of future behavior. However, rate may be less useful as an indicator of response strength if it is intended to be used to predict behavior across a variety of situations (i.e., where different contingencies are likely to be in place). When conditions are expected to change, persistence may be more useful as a measure, because it provides an index of response strength based on measuring responding when conditions change. In sum, rate and persistence may both provide useful indices of response strength but may be more or less appropriate in different situations.

Behavioral Momentum Theory

Behavioral momentum theory elegantly summarizes a large body of basic research findings on rate and persistence of behavior and may have important implications for effective programming in applied settings. The theory is based on an analogy between behavior and physical momentum. In physics, momentum (P) is the product of mass (m) times velocity (v), that is, $P = m v$. Several features of physical momentum are particularly relevant for the analogy. As the mass or velocity of a moving object increases, the momentum of that object increases and relatively more energy is needed to disrupt (e.g., change, deflect, slow, or stop) the movement of

that object. Mass and velocity are separate components of momentum, such that two objects traveling at the same velocity can have different masses. Under these conditions, the object with more mass has more momentum and will take relatively more energy to be stopped or redirected. In addition, one can measure velocity by observing an object, whereas one cannot measure mass simply by observing (unless the density of the material is known). Mass and velocity require different measurement strategies.

Behavioral momentum theory proposes that operant behavior is analogous to the momentum of a moving object. Just as physical momentum predicts that an object set in motion will continue in motion, behavioral momentum theory predicts that once a behavior is exhibited and reinforced, it will continue to be demonstrated under similar conditions (i.e., it will have *behavioral momentum*, Nevin, 1995; Nevin, Mandell, & Atak, 1983). According to the analogy, rate of responding and persistence (also called resistance to change or resistance to disruption) are analogous to velocity and mass, respectively. Thus, behavioral momentum is determined both by the rate of a behavior and the persistence of behavior, such that the rate indicates the current level of the behavior and persistence indicates the tendency to continue despite disruptions.

Behavioral momentum theory was originally proposed to highlight the finding that while two behaviors may occur at the same rate, this does not mean that they have the same persistence (Nevin et al., 1983). Behavioral momentum theory suggests that the stronger behavior is the one that is more persistent. Similar to velocity and mass in physical momentum, one cannot measure rate and persistence using the same strategy. Rate may be calculated by counting the number of responses in a given period of time. Persistence, however, must be calculated by comparing a baseline measure of responding to responding when exposed to some disruptor (i.e., a manipulation that changes levels of responding). In other words, similar to physical mass, behavioral mass (i.e., persistence) cannot be identified by simply observing a response at a single

point in time. More importantly, two responses occurring at the same rate cannot be assumed to be similarly persistent.

Just as physical momentum can be separated into velocity and mass, behavioral momentum theory suggests that rate of responding and persistence are separable aspects of behavior (Nevin, 1984; Nevin et al., 1983). Specifically, rate of responding is determined by the reinforcement contingency (i.e., response-reinforcer relation). Research consistently demonstrates that rate of responding is directly controllable by arranging different reinforcement contingencies (e.g., Skinner, 1953), with differential reinforcement of high- versus low-rates of responding providing a clear example of control over rate. Therefore, the response-reinforcer contingency is an operant relation. Behavioral momentum suggests that persistence of responding is determined by the rate of reinforcement present in a context (i.e., stimulus-reinforcer relation) rather than the contingency. This relation between reinforcers and stimuli is a Pavlovian relation, because the total reinforcement occurs in the presence of the contextual cues not as a consequence for a specific response (Nevin, Tota, Torquato, & Shull, 1990). The total rate of reinforcement in a context is composed of contingent reinforcement for a target response, contingent reinforcement for other responses, and noncontingent reinforcement (i.e., reinforcement obtained independent of responding).

Behavioral momentum theory proposes that a low rate behavior occurring in a context of richer reinforcement will be more persistent than a high rate behavior occurring in a context of leaner reinforcement. Further, the richness of a context is a result of all reinforcement available in that context, not just reinforcement that is contingent on a given target behavior. Behavioral momentum may have at least two important implications for practice. First, rate of responding may not be an adequate measure of response strength in some cases, because it may not sufficiently predict persistence of a response when conditions change. Second, adding

reinforcement into a context can increase persistence of a response even if it is not contingent on that response.

CHAPTER II

LITERATURE REVIEW

Basic Studies

Researchers typically conduct basic research on behavioral momentum using multiple schedule preparations. A multiple schedule includes two or more independently operating reinforcement schedules, each associated with a distinct stimulus. Each schedule and corresponding stimulus is called a component and there is usually a period between consecutive components called an intercomponent interval (ICI) where none of the component schedules or associated stimuli are present. A session is typically made up of many alternations between the components, such that a session might last 1 hour and be made up of an equal number of two different components, each lasting 1 min. For example, in the presence of a steady house light, every lever press results in access to one food pellet, and in the presence of a flashing house light, every third lever press results in access to one food pellet.

The multiple schedule components in behavioral momentum research are typically rich and lean contexts. The same free operant response is targeted in two contexts with different schedules of reinforcement: The rich context includes a higher rate of reinforcement than the lean context. After stable responding is established, some change, called a disruptor, is made to both contexts. The purpose of the disruptor is to alter levels of the response and allow for measurement of changes in responding (i.e., decreases) in the two contexts. Common disruptors include extinction (e.g., food is no longer delivered following responses) or satiation-based procedures (e.g., providing free access to food before sessions or during the ICI). In addition, researchers have used punishment to disrupt responding (e.g., Blackman, 1968, Experiment 2; Bouzas, 1978). Results of the disruption operation are typically calculated across sessions by dividing the mean response rate under disruption by the mean response rate from several sessions

before disruption (e.g., across the five sessions before disruption). The outcome is called *proportion of baseline* and is considered to be a measure of persistence (i.e., response strength), such that higher proportion of baseline indicates greater response strength acquired during pre-disruption learning. Within-session persistence has also been measured (i.e., decreases in responding under disruption within a given session; Tonneau, Ríos, & Cabrera, 2006).

An early study in this line of research examined the relative persistence of behavior when exposed to higher or lower rates of reinforcement (Nevin, 1974, Experiments 1 & 2). Using a multiple schedule, pigeons' responding was reinforced on a richer VI schedule in one context (e.g., green key) and on a leaner VI schedule in a second context (e.g., red key). Following baseline exposure to these reinforcement schedules, persistence was measured when disrupted by additional access to food between contexts in Experiment 1 or extinction in Experiment 2. Results demonstrated that relative to baseline, the context in which rate of reinforcement had been higher was associated with more persistent responding. The reason for this differential persistence was somewhat obscured, however, because the richer context was also associated with slightly higher rates of responding in baseline. Therefore, it was unclear if greater persistence was due to rate of reinforcement, rate of responding, or some combination of both. Also in this study, Nevin (Experiments 3, 4, and 5) provided preliminary evidence that larger magnitudes of reinforcement, shorter delays to reinforcement, and richer rates of reinforcement resulted in relatively more persistent responding.

To further examine the effects of rate of responding and rate of reinforcement on persistence of behavior, Nevin et al. (1990, Experiment 1, Conditions 2 & 3) attempted to separate response rate and persistence by comparing two conditions with pigeons. In one context signaled by a colored key light (e.g., green), pigeons earned food for pecking a key on a variable interval (VI) schedule. In the second context, associated with a different key light (e.g., red), the pigeons earned food for pecking on the same VI schedule with additional food provided on a

variable time (VT) schedule regardless of responding (i.e., noncontingently). In baseline, the VI condition produced higher rates of responding than the VI + VT condition. Thus, in the VI + VT condition the birds received a higher rate of reinforcement but responded at lower rates than in the VI condition. This allowed the researchers to evaluate the distinct effects of rate of reinforcement and rate of responding on persistence. When the pigeons' key pecking was subsequently disrupted using extinction or free access to food before sessions, responding was more persistent in the condition previously associated with the higher rate of reinforcement (i.e., VI + VT). In other words, despite the lower response rate in the VI + VT context during baseline, responding was more persistent when disrupted in this context. This result is not expected if rate of responding is considered the most appropriate index of response strength: If rate of response is the best measure of response strength (e.g., Skinner, 1938), then the VI schedule alone (i.e., lean context) should have resulted in greater persistence. In addition, this result demonstrated that the addition of reinforcement that is noncontingent can increase persistence of behavior.

Research on behavioral momentum has consistently demonstrated that when different contexts are arranged with different rates of reinforcement in a multiple schedule, the context associated with the higher rate of reinforcement will be associated with relatively greater persistence (see Nevin & Grace, 2000 for a review). These results have been demonstrated using pigeons (Nevin, 1974; Nevin et al., 1990), rats (Cohen, Riley, & Weigle, 1993), undergraduate students (Cohen, 1996), goldfish (Igaki & Sakagami, 2004), children (Tota-Faucette, 1991, Experiment 2), and monkeys (Hughes & Branch, 1991). Researchers have demonstrated that providing reinforcement on a denser schedule (e.g., rich VI vs. Lean VI, Nevin, 1974, Experiment 1), delivering additional response independent reinforcers (e.g., VI vs. VI + VT, Nevin et al., 1990, Experiment 1, Conditions 5 & 6; Podlesnik & Shahan, 2008), and providing additional reinforcers for alternative responses (e.g., reinforcing pecking on a second key, Nevin et al.,

1990, Experiment 2) have identical effects; higher rate of reinforcement in a context results in greater persistence. This result has also been demonstrated when the noncontingent reinforcers are different from the contingent reinforcers (e.g., contingent food plus noncontingent sweetened condensed milk, Grimes & Shull, 2001; contingent points plus noncontingent food, Tota-Faucette, 1991, Experiment 2). Additional research has shown that relatively greater magnitudes (as opposed to high rates) of reinforcement also produce greater persistence (e.g., Nevin, 1974, Experiment 3; Harper, 1996).

An essential similarity across these findings is the presence of different contexts associated with different amounts of reinforcement. The context associated with more reinforcement is also associated with more persistent responding when exposed to disruptors.¹ Another important finding is that behavior may be similarly persistent when contexts include different rates of *contingent* reinforcement for a target response provided the *overall* rates of reinforcement in each context are similar. Nevin et al. (1990, Experiment 1, Conditions 5 & 6; see also Podlesnik & Shahan, 2008, Experiment 2) compared persistence of key pecking in pigeons when two contexts included the same overall rates of reinforcement. In Condition 5 and 6, pigeons earned a total of 60 reinforcers per hour in both contexts, signaled by colored keys. The green-key context arranged reinforcers on a VI 60 s schedule, and the red-key arranged reinforcers on a VI 20 s + VT 40 s or VI 12 s + VT 48 s in Conditions 5 and 6, respectively. These conditions allowed for examination of the effects of different levels of contingent reinforcement for key pecking across contexts while maintaining the same overall rate of reinforcement. In baseline, higher rates of responding were found in the context that produced the higher rate of contingent reinforcement (green key, VI 60 s) for both Condition 5 and 6.

¹ Considerable evidence exists demonstrating that higher rates of reinforcement result in greater persistence under disruption relative to lower rates of reinforcement (see Nevin & Grace, 2000). However, when researchers have equated rates of reinforcement across two contexts, they have found a small but consistent difference in relative persistence (i.e., the lower rate response is more persistent, see Nevin, Grace, Holland, & McLean, 2001). This effect however is only observable when all other reinforcement parameters are held equal (e.g., rate of reinforcement, reinforcer magnitude, and delay to reinforcement).

Under disruption, similar levels of persistence were found across the contexts (both the green- and red-key). These results suggest that response strength (as measured by persistence) did not depend on rates of responding or specific reinforcement contingencies. Further, noncontingent reinforcement decreased the rate of a target response, but not persistence of that response when it was subjected to a disruptor (relative to the richer context).

In Experiment 2, Nevin et al. (1990) replicated Experiment 1, except that instead of arranging noncontingent reinforcement, reinforcement for an alternative response was added in one context. They arranged the same overall rate of reinforcement in two contexts, such that in one context (two white keys), 60 reinforcers per hour were provided for the target response (right key pecking). In another context (two green keys), 45 reinforcers per hour were provided for an alternative response (left key pecking) and only 15 reinforcers per hour were contingent on the target response (right key pecking, 60 total reinforcers per hour across both responses). With these reinforcement schedules, response rates for pecking on the right key were higher in the context with all reinforcement for the target response (white keys). Under disruption however, persistence was similar in both conditions. These results again support behavioral momentum theory, because similar persistence is predicted based on similar total rates of reinforcement for all responses in a given context. Neither rate of responding nor rate of contingent reinforcement for the target response predicted persistence. In addition, results suggest that switching reinforcement from a target response to an alternative responses may decrease the rate of a target response but have no effect on the persistence of the target response.

Similar levels of persistence have also been found when specific pacing contingencies were used to reinforce responding on identical concurrent VI schedules (Fath, Fields, Malott, & Grossett, 1983). Specifically, Fath et al. arranged pacing requirements for relatively faster and slower responding in two contexts, yet both contexts arranged a similar rate of reinforcement using a VI 60 s schedule. When responding was disrupted by presenting noncontingent

reinforcement (free food) between components of the multiple schedule, persistence was the same in both contexts despite different baseline levels of responding. This finding again illustrates that rate of responding is not predictive of relative response strength as measured by persistence.

Basic researchers have applied behavioral momentum theory to behavioral models of relapse (i.e., reinstatement, resurgence, and renewal). Models of relapse are used to examine increases in a target behavior following interventions that reduce the occurrence of the target behavior (e.g., extinction). Specifically, after a target behavior is extinguished, *reinstatement* is typically arranged by providing noncontingent access to one or a few reinforcers at the beginning of a session and measuring increases in the target behavior (the target behavior remains under extinction). *Resurgence* is produced by first extinguishing the target behavior and simultaneously reinforcing an alternative response, then placing the alternative response on extinction. Experimenters then measure increases in the level of the original target response, which is still under extinction. In *renewal*, the target response is trained in one setting, extinguished in a different setting, then the subject is returned to the first setting and increases in the target response are measured (the target behavior remains under extinction). Regardless of the model used to examine relapse, greater increases have been found in contexts previously associated with richer reinforcement (see Podlesnik & Shahan, 2009 for research on behavioral momentum and reinstatement, resurgence, and renewal).

Researchers have consistently found that certain manipulations result in greater persistence regardless of their immediate effects of decreasing rate. In addition, researchers have noted that the same manipulations that increase persistence have also been found to increase preference when assessed in a concurrent chains procedure (see Nevin & Grace, 2000 for a review and conceptual discussion). In the concurrent chains procedure, a subject is presented with two or more response options (e.g., pecking on the right or left key), called the initial links of the concurrent chains. Responses to each option results in access to a specific terminal link,

usually defined by a different reinforcement schedule (e.g., VI 60 s following right key pecks and VI 240 s following left key pecks). The response requirements in the initial links are usually identical and therefore, measuring responses to the initial links provides a measure of preference between different outcomes arranged in the terminal links. If preference was assessed without the initial links, however, results could be confounded because the differences in the terminal links may reinforce certain response patterns (e.g., high-rate responding) that could mask preference (e.g., for the lower rate response). In their review, Nevin and Grace noted that the parallel effects of rate of reinforcement (i.e., increased persistence and preference) suggest that persistence and preference may provide related measures of response strength.

The consistent findings of research on behavioral momentum theory presents problems for some traditional definitions of reinforcement. These challenges arise from the fact that greater persistence is associated with richer contexts even if the additional richness is due to noncontingent reinforcement (or reinforcement for alternative responses) and despite lower rates of responding in the rich context. This result seems contrary to common definitions of reinforcement: “If a behavior is followed closely in time by a stimulus event and as a result the future frequency of that type of behavior increases in similar conditions, **reinforcement** has taken place” (Cooper, Heron, & Heward, 2007, p. 36, emphasis in original). Definitions of reinforcement from other sources similarly include the components of contingent events and increasing frequency (e.g., Michael, 1995, 2004) or contingent events and increased frequency or probability (Alberto & Troutman, 2006; also noted in Cooper et al., 2007). Thus, the term “reinforcer” will be used in this paper as it has been used in the behavioral momentum research,

i.e., as a term for presentation of stimuli that strengthen behavior, as indicated by persistence, regardless of contingency or effect on immediate rate of responding.²

Potential Implications for Practice

The majority of research examining behavioral momentum has used basic preparations, including arbitrary responses and animal subjects. Translation or application of behavioral momentum theory to applied settings has received limited attention. Despite the dearth of applied research on behavioral momentum, the consistent outcome of higher reinforcer rate resulting in greater persistence has lead to questions about several types of interventions commonly implemented in applied settings. In addition, the body of research on relapse and behavioral momentum has shown that following the complete elimination of target behaviors in two contexts (i.e., rich and lean), the target behavior may increase relatively more in the context previously associated with richer reinforcement. Thus, concerns over applied procedures are a direct outcome of the consistent basic finding that noncontingently delivered reinforcers and reinforcers delivered for alternative behaviors can reduce response rates but also increase persistence and magnitude of relapse of the target behavior. Behavioral momentum also predicts that, while counterintuitive, it may be possible to increase the persistence of desirable responses by using reinforcement procedures that are unrelated to the target responses and may decrease the rate of the response.

² Research on behavioral momentum has consistently used the terms *reinforcer* and *reinforcement* for stimuli that have known reinforcing effects (evidenced in baseline) even if specific presentations of a stimulus are not contingent and do not have a rate increasing effect (e.g., Nevin et al., 1990). This terminology has not been limited to behavioral momentum research with animal subjects (e.g., Mace et al., 1990) which suggests that the appropriateness of the terms are not due to some aspect of the animal preparation. In fact, these terms have been used in other discussions of translational research where stimuli are presented independent of responding and decrease rates of responding (e.g., McDowell, 1988; Vollmer & Hackenberg, 2001). The terms *reinforcer* and *reinforcement* have been commonly used in applied research for delivery of stimuli during procedures based on either noncontingent reinforcement or differential reinforcement of other behavior (DRO), both of which include delivery of stimuli that are not contingent on a response and generally reduce the levels of some target behavior (see Poling & Normand, 1999; Vollmer, 1999 for further discussion related to applied research on noncontingent reinforcement and DRO). In advocating for precise usage of "reinforcement," it has been suggested that the term "reinforcement" be reserved for situations in which a behavior "increases in rate, or is otherwise strengthened" (Poling & Normand, 1999): It seems then these terms are appropriately used in behavioral momentum given the strengthening of behavior proposed and evidenced by measures of persistence.

Relative to desirable behaviors, such as appropriate classroom etiquette or correct responses to educational programs, practitioners often focus on providing contingent reinforcement for the desirable responses and ensuring there is little or no reinforcement for non-target responses. It is possible that the desirable responses could be additionally strengthened by providing more reinforcement for the target responses, as well as other responses or noncontingently, as long as the reinforcement is provided in the context where the target behavior occurs. For example, providing additional reinforcement noncontingently may not appreciably decrease response rates, yet increase the persistence of academic responses. If the persistence of the desirable responses is increased, this may then lead to improved generalization and maintenance, because changes in stimulus conditions and reinforcement contingencies are the essence of generalization and maintenance. In other words, testing for generalization and maintenance necessarily includes presenting some disruptor, and when the target response persists, it is said to have generalized or maintained. Similarly, a goal of academic programming is to teach students to respond correctly, even when distracted or when they are not receiving explicit reinforcement. Relatively richer reinforcement may help students continue to work in the presence of distractions.

Relative to behaviors targeted for reduction, basic arrangements that provide additional reinforcement noncontingently or for alternative responses appear to closely approximate several commonly used interventions in applied settings. These interventions include differential reinforcement of alternative behavior (DRA; including functional communication training, FCT), differential reinforcement of other behavior (DRO), differential reinforcement of incompatible behavior (DRI), and noncontingent reinforcement (NCR). Each of these therapeutic interventions introduce reinforcers to a situation in order to decrease the rate of the target response and in some cases increase one or more alternative behaviors. However, the addition of reinforcers may increase the overall rate of reinforcement in that context and thereby increase persistence of the

behaviors targeted for decrease (i.e., the challenging behavior) and also may result in relatively greater relapse of that response in the future. It is important to note that, based on behavioral momentum theory, this potential increase in persistence and relapse would be expected to occur despite decreased contingent delivery of reinforcers for challenging behavior and reductions in the rate of challenging behavior. In addition, greater persistence would even be expected if additional or noncontingent reinforcement reduced the challenging behavior to zero rates, because the context is still associated with a history of the challenging behavior and richer reinforcement. It is possible then, that some interventions that successfully reduce contingent reinforcement for challenging behavior and reduce the rate of challenging behavior may, in fact, increase the persistence and result in greater relapse of these behaviors. Furthermore, this potential increase in persistence will likely go unnoticed if rate of response is the primary measure of intervention effectiveness.

However, many assumptions are required to make this kind of leap from theory based on basic animal research to interventions in applied settings. Behavioral momentum theory may suggest potential intervention options or raise questions, but a great deal of translational research is needed before we can determine how behavioral momentum operates in complex applied settings. To examine the relevance of behavioral momentum research to applied settings, translation should start in areas where intervention procedures could be most helpful or problematic procedures may be common. One area where these interventions may be common is in interventions for persons with developmental disabilities. Individuals with developmental disabilities, such as autism, are more likely than their typical peers to require individualized interventions targeting educational responses (e.g., on-task behaviors, independence) or challenging behavior (e.g., aggression, disruption, stereotypic behaviors).

Behavioral Momentum Research with Persons with Disabilities

Relatively few studies have examined behavioral momentum with individuals with disabilities (i.e., Ahearn, Clark, Gardenier, Chung, & Dube, 2003; Dube & McIlvane, 2001, 2002; Dube, McIlvane, Mazzitelli, & McNamara, 2003; Lerman, Kelley, Vorndran, Kuhn, & LaRue, 2002; Mace et al., 1990; Mace et al., 2010) and no translational studies have examined relapse and behavioral momentum with individuals with disabilities. An early study examined persistence of silverware sorting with two individuals with mild or severe mental retardation using a multiple schedule (Mace et al., 1990). Contexts in this study were defined by color: Participants sorted red or green sets of silverware. Contexts were arranged to compare VI 60 s vs. VI 240 s schedules (Experiment 1) and VI 60 s vs. VI 60 s + VT 30 s schedules (Experiment 2). It is worth noting that component lengths were only three minutes and therefore, by arranging a VI 240 s, schedule, the researchers were arranging components where reinforcement was improbable. After initial training, disruption was arranged by having a television program available as a distracter. For both participants in Experiment 1, rates of responding were equivalent in the rich and lean contexts. When disrupted, responding was more persistent in the rich context than the lean context, indicating greater persistence in the rich context despite identical rates of responding in baseline. For both participants in Experiment 2, the same VI 60 s schedule was arranged in both contexts. The rich context was arranged by adding additional reinforcers noncontingently (i.e., on a VT schedule) in that context. The additional noncontingent reinforcers in the rich context resulted in lower rates of responding in the rich context relative to the lean context. Under disruption, however, responding was more persistent in the rich context and rates of responding in the rich context were then higher than in the lean context. Results indicated that silverware sorting was more persistent in the context associated with the higher rate of reinforcement. In addition, the results of Experiment 2 indicate that while rates of responding in the rich context were lower than rates of responding in the lean context before disruption, the

rich context resulted in higher rates than the lean after disruption. This result cannot be predicted by examining rate of responding before disruption.

Dube and McIlvane (2001, 2002) and Dube et al. (2003) have also conducted research on behavioral momentum with individuals with disabilities. These studies examined persistence of responding to simple computer-based tasks, such as touching icons on the computer screen. Contexts were defined by different colored icons or computer screens and were associated with richer or leaner schedules of reinforcement. These studies again found that contexts associated with relatively higher rates of reinforcement resulted in greater persistence. Only one study (Dube et al., 2003) arranged the rich context by adding noncontingent reinforcement. When additional reinforcement was available noncontingently, rates of responding in the rich context were lower than in the lean context, yet responding was more persistent in the rich context.

Dube and McIlvane (2002) used trial-based procedures to examine persistence. Trial-based procedures involve presentation of a discriminative stimulus and contingent reinforcement for correct responses in the presence of that stimulus. Using this arrangement, participants are not free to vary their rate of responding, and therefore measuring persistence requires some modifications to the behavioral momentum research preparations described above. Specifically, after trial-based discriminations were trained to criterion, disruption was arranged by changing the target discrimination and measuring trials to learn the new discrimination. Persistence was expressed as a change in accuracy rather than rate of responding. Thus, a greater number of errors indicated more persistence (i.e., participants continued to respond according to the originally acquired discrimination for a greater number of trials). The results of Dube and McIlvane (2002) suggest that richer schedules of reinforcement increase persistence of trial-based responding and provide overall support for behavioral momentum theory. Trial-based teaching procedures are commonly used with persons with disabilities, so this study provided evidence that

effects consistent with behavioral momentum could be found when using a common applied practice.

In one example of published behavioral momentum research targeting inappropriate behavior in individuals with disabilities, Ahearn and colleagues (2003) examined levels of stereotypy in three individuals with autism. They compared the effects of two different session arrangements. One arrangement included access to high-preference stimuli, hypothesized to functionally represent an increased rate of reinforcement (rich context), while the other format did not (lean context). Specifically, their method arranged a series of four 5-min components in a 20-min session (a] baseline, b] presence/absence of high-preference stimuli, c] disruption test that included stimuli identified to compete with stereotypy, d] baseline). When high-preference stimuli were present in NCR-based interventions (component b, rich context), stereotypy was lower than when high-preference stimuli were not present (component b, lean context). However, the 5-min disruption test following access to high-preference stimuli (rich context) showed more stereotypy than this test following periods when the high-preference stimuli were not available (lean context). Put simply, while levels of stereotypy decreased in the rich component compared to the lean component; during disruption stereotypy was higher in the rich component than the lean component. The authors concluded this was an increase in persistence in the context with additional reinforcement, consistent with a behavioral momentum interpretation.

It is unclear if understanding the results of Ahearn et al. (2003) in terms of behavioral momentum is appropriate given some important differences from previous research. Because it is difficult to quantify the reinforcement provided by stereotypy, it is difficult to say if a 5-min period with lower rates of stereotypy and concurrent access to high-preference stimuli is in fact richer than a similar 5-min period with greater occurrence of stereotypy but no access to high-preference stimuli. In addition, each participant only had three or four exposures to rich and lean contexts and disruption was introduced immediately after each rich or lean context. In contrast,

in basic research on behavioral momentum, procedures include many opportunities for subjects to contact the contextual cues for rich and lean contexts: Exposure to disruption occurs after stable levels of behavior are seen in each context. Thus it is unclear if the brief contact and few exposures to the rich and lean contexts were sufficient to establish the differential histories necessary for increased persistence under disruption due to behavioral momentum effects.

As an alternative to a behavioral momentum interpretation, it is possible that the presence of high-preference stimuli in 5-min components could have functioned to increase stereotypy during the next 5 min for reasons other than increased rate of reinforcement in the context. For example, because interacting with high-preference stimuli in the rich context resulted in lower levels of stereotypy, it may have created a state of deprivation of the consequences of stereotypy. In the lean context, however, the same deprivation was not present. In summary, the two contexts arranged differential states of deprivation for the consequences for stereotypy, and each context was then immediately followed by observing levels of stereotypy. It is not surprising that the context associated with greater deprivation resulted in greater levels of stereotypy.

Lerman et al. (2002) examined extinction as a disruptor for responding maintained by either escape from demands or access to tangibles with individuals with disabilities. They arranged relatively rich and lean contexts by providing different magnitudes (i.e., durations) of reinforcers in two contexts. They found no differential persistence in responding for three participants, despite one context being associated with richer reinforcement before disruption (i.e., results were not consistent with behavioral momentum theory). Context was arranged by having a different person associated with the rich and lean contexts. It is possible, therefore, that effects consistent with behavioral momentum were not found because staff did not function as context. Alternatively, the rich and lean contexts may have not been sufficiently different to establish differential persistence, although the three to one ratio of rich to lean reinforcement arranged in this study has been effective in previous research. Finally, it is possible that effects

consistent behavioral momentum may not be robust enough to be observed in some complex applied situations, similar to those used by Lerman et al.

This study had several differences from previous studies that may have impacted results. First, in the case of escape as a reinforcer, a longer escape interval was considered richer, yet it is unclear if 60 s escape was, in fact, more reinforcing than 20 s of escape. It seems possible that in the absence of the relevant MO, task demands, additional time without demands may not have been more reinforcing. In other words, the reinforcing event, termination of aversive stimulation, may have been equal in both contexts, regardless of different escape intervals. In the case of responding maintained by access to tangible items (i.e., leisure or edible items), items were identified via a paired stimulus preference assessment (Fisher et al., 1992), which typically includes measuring approach responses and result in access to approached items for relatively brief periods (e.g., 10-30 s). Steinhilber and Johnson (2007) demonstrated that different durations of access to leisure items in preference assessments can result in different preference hierarchies, so it is possible that the leisure items used with one participant were no more reinforcing with 60 s access as compared to 20 s access. Thus, it is somewhat unclear if one context was, in fact, richer than another and therefore it is difficult to make predictions of relative persistence in this case.

More recently, Mace et al. (2010) examined persistence of challenging behavior when DRA procedures were arranged to reduce levels of the challenging behavior. They examined persistence to disruption (response blocking) when it followed either reinforcement of the challenging behavior or reinforcement of the challenging behavior plus DRA. They found the challenging behavior was more persistent (resistant to response blocking) when it followed the reinforcement plus DRA condition than when response blocking followed reinforcement alone. They concluded that the reinforcement plus DRA condition functioned as a richer context and thus, challenging behavior was more persistent.

Several disruptors have been used in translational studies on behavioral momentum with participants with developmental disabilities. In general, disruption has been arranged by providing one or more alternative items or activities, such as a television program (Mace et al., 1990), games (Dube et al., 2003), or noncontingent reinforcement before and during the session with alternative activities (Dube & McIlvane, 2001). Mace et al. (2010), however, used response blocking to disrupt participant behavior. Across the different disruptors, increased persistence has consistently been found in contexts previously associated with higher rates of reinforcement.

Despite concerns related to increasing persistence of challenging behaviors with behavioral interventions that include adding reinforcement, there are few studies examining challenging behavior and behavioral momentum in persons with disabilities (Ahearn et al., 2003; Lerman et al., 2002; Mace et al., 2010). In addition, some of these studies are difficult to interpret relative to behavioral momentum theory, given the specific procedures used (i.e., Ahearn et al., 2003). Examining challenging behavior in the context of research on behavioral momentum may be less common than other target responses for several reasons. First, some challenging behaviors may be difficult to disrupt using conventional disruptors (i.e., extinction and satiation operations). For example, automatically maintained behaviors are not amenable to withholding reinforcers or delivery of reinforcers to the point of satiation, because the reinforcer is not easily manipulated by experimenters. Relative to aggressive behaviors, it may be possible to frequently deliver the same or similar reinforcer independent of responding (i.e., attention). However, it may not be safe to implement extinction procedures, because it would typically entail allowing the aggression to occur without delivery of the identified reinforcer, which may result in serious injury to the experimenter or participant.

Second, for many challenging behaviors, it may be difficult to quantify how much reinforcement is accessed in each context and therefore determination of the rich and lean contexts may be easier said than done. For example, one context might provide social attention in

the form of a reprimand (i.e., reinforcement) for challenging behavior after every response. A second context could include providing additional reinforcement for alternative behaviors (e.g., praise or tangible items for requesting attention) in addition to reprimands for challenging behavior. If the second context results in a lower level of challenging behavior but more alternative reinforcers (praise or tangibles) relative to the first context, it is unclear which context actually has more reinforcement overall (i.e., it is unclear if accessing reprimands is richer than accessing fewer/no reprimands with addition of praise or tangibles). Therefore predictions of persistence based on relative rate of reinforcement may be difficult to make or test.

There are several potential reasons why challenging behavior has rarely been examined in previous research, yet it is less clear why current academic programs have not been examined in research on behavioral momentum. Current academic behaviors may be incorporated into research on behavioral momentum similarly to arbitrary responses, because the academic behaviors are often discrete responses (e.g., completing math problems or spelling words) and social reinforcement for such behaviors is typically easily manipulated by teachers (e.g., points, edible items, praise). A goal of academic programming is to increase correct responding and also to increase the persistence of responding despite potential disruption, such as the presence of a substitute teacher, decreases in reinforcement, or other planned or unplanned changes to the learning situation. Therefore, while previous research has not examined current academic responses, these behaviors may provide an important extension of existing research on behavioral momentum and may provide useful information for addressing some of the practical challenges of conducting behavioral momentum research on challenging behaviors.

An important goal of translating behavioral momentum research is to identify features of populations, interventions, settings, and behaviors in which the unique predictions of this theory are relevant. To date, translational research has only begun to examine these features with persons with disabilities.

Conclusion

An important function of basic behavioral research is to identify principles of behavior that may have broad practical applicability. When basic research findings suggest potentially important implications for practice, researchers should begin to test these implications in translational research. Behavioral momentum theory elegantly describes the results from a large body of basic behavioral research. This literature demonstrates that adding reinforcement to a context may increase persistence, even if responses decreased in rate before disruption (e.g., Mace et al., 1990; Nevin et al., 1990). This demonstrates that rate of responding is not inherently predictive of persistence of behavior. Furthermore, these results indicate that reinforcement need not be contingent to increase persistence. Finally, richer contexts may result in greater increases in responding following extinction (e.g., relapse, Podlesnik & Shahan, 2009).

The findings of research on behavioral momentum theory raise questions when thinking about common interventions for persons with disabilities; interventions to increase behaviors may limit reinforcement for non-target responses, and interventions to decrease challenging behaviors often involve increasing the overall rate of reinforcement (e.g., adding differential or noncontingent reinforcement). Additionally, because applied situations often involve complex arrangements of contingencies and changing situations, examining rate of responding alone may not capture all relevant effects of interventions. Initial translational research has demonstrated that momentum effects can be found with persons with disabilities under some circumstances (i.e., Dube & McIlvane, 2001, 2002; Dube et al., 2003; Mace et al., 1990, 2010). These studies, in combination with extensive basic research, provide a foundation for further translational research that explores the variables that determine the ways in which behavioral momentum effects (i.e., increased or decreased persistence) may be manifest in applied situations.

To extend behavioral momentum theory into applied research areas, translational research must allow for quantification of relative reinforcer rates and rates of responding across

contexts. In addition, it would be beneficial to use methods that arrange lower rates of responding in the rich context relative to the lean context. This arrangement allows for separation of the effects of reinforcer rate and response rate on persistence. In basic research, this has been accomplished using a multiple schedule to compare responding reinforced on a VI schedule in one context to responding reinforced on a VI + VT schedule in a second context. This comparison also arranges additional reinforcers similarly to noncontingent reinforcement, which replicates or approximates some common intervention strategies for individuals with disabilities. Thus, in the early stages of translation, research should focus on similar arrangements of reinforcement schedules (i.e., VI and VI + VT). While these reinforcement features are important for systematic translation of behavioral momentum theory, other methodological aspects may be less critical; for example, comparisons of context could be imbedded within a multiple baseline design. This would not affect the contextual comparison, but would extend behavioral momentum research into experimental designs common to applied research and may set the stage for later research to use similar design features.

In translational behavioral momentum research, disruptors should be selected to approximate potential disrupting conditions in applied situations, such as planned or unplanned changes to interventions (e.g., fading interventions or treatment integrity failures). Previous translational research has primarily included alternative reinforcing activities as disruption for target behaviors (i.e., distractions). While distractions may be present in applied situations, they may be less germane for understanding common disruptors for fading interventions for academic responses or challenging behavior. During interventions with fading of academic supports or programs for challenging behavior, primary concerns would be related to treatment integrity or generalization issues instead of the presence of distracting alternatives. For academic programs, extinction conditions may be encountered during the planned fading of an intervention, when an individual transitions from one environment to another (e.g., familiar classroom to new

classroom), or from interacting with one person to another (e.g., familiar teacher to unfamiliar teacher). For challenging behavior, if less experienced teachers or care givers fail to follow interventions protocols, then reinforcers may be delivered on a leaner schedule than designed or not at all. Additionally, individuals with disabilities may be likely to reencounter reinforcement in the context in which a behavior was previously placed on extinction, which is functionally similar to the reinstatement model of relapse. Therefore, in translating behavioral momentum research into applied situations, extinction may provide a representative disruptor in initial studies and reinstatement may model conditions that occur in applied settings.

Most of the existing translational research on behavioral momentum has focused on arbitrary responses rather than targeting behaviors that are socially relevant and have long histories of reinforcement. Challenging behaviors are, of course, a critical target of translational research; however, given the practical difficulties with clearly operationalizing behavioral momentum in research on challenging behavior, it might be useful to include current academic responses as opposed to novel (i.e., arbitrary response). The advantage of including current academic responses is that they may be considered socially relevant and, as such, include important characteristics that may be absent in arbitrary responses. Specifically, current academic responses include a history of reinforcement and are likely affected by contingencies in the natural settings outside of experimental sessions (e.g., may be part of a larger response class). Additionally, increasing the persistence of academic responding is an important goal for students with disabilities. Therefore, the inclusion of socially relevant responses, such as current academic responses, may be particularly important for understanding the relation between behavioral momentum theory and behavioral persistence in applied situations.

In behavioral momentum theory context is integral to obtaining and identifying differential persistence. To date, studies including participants with disabilities have also

included only basic operationalizations of context, i.e., salient color cues.³ One dimension of translation of behavioral momentum theory from basic to applied research is to identify contextual variables that are common in applied situations. Moreover, determining contextual variables that may be readily manipulated in applied settings while also being highly salient may be important for future research on applications of behavioral momentum theory. Therefore the following research questions guided this research:

Given two contexts in a school setting (defined by the presence of different staff members) in which a current academic response is maintained with contingent reinforcement, what are the effects of providing additional noncontingent reinforcement in one context? Effects of interest include:

- A - rate of responding during reinforcement conditions,
- B - rate of responding during subsequent extinction condition,
- C - persistence of responding during subsequent extinction,
- D – relapse (i.e., reinstatement) of responding following extinction.

Examining rate of responding during reinforcement (question A) is important to identify the effects of contingent reinforcement with and without additional noncontingent reinforcement. This is expected to demonstrate that immediate effects of these conditions are consistent with previous behavioral momentum research and with applied research on effects of the addition of noncontingent reinforcement. Rate of responding during the extinction condition (question B) is important, because in applied settings, it is rate of behavior, not proportional change from a previous condition that determines the degree to which the target behavior has been adequately addressed. Persistence of responding during extinction (question C) is the central question of this research. Greater persistence in the rich condition would extend behavioral momentum research

³ Lerman et al. (2002) compared persistence using a reversal design with contexts defined by staff members and specific “work tables,” yet, given the results of this study, it is still unclear if staff members can function as context for differential persistence.

and provide additional evidence that implications of this research may be important in applied settings. Examining differences in increases in the target behavior following extinction (i.e., relapse; question D) provide an additional measure effects consistent with behavioral momentum theory. In addition, each of these contrasts will provide evidence on the degree to which staff people in applied settings can function as contexts for behavioral momentum effects.

CHAPTER III

METHOD

Participants and Setting

Four preschool-aged students participated. All participants were students in a public school preschool classroom for children with characteristics of autism. Participants generally displayed similar levels of skills and abilities, including engaging in vocal communication, typical or near typical gross and fine motor skills, and generally low levels of aggressive and disruptive behaviors. Participants were preliminarily identified if they had a history of engaging in at least one educational task that did not require ongoing teacher instructions or prompting and were successful with educational activities with intermittent reinforcement.

Ed was 4.3 years old at the beginning of the study and had an educational classification of autism. Ed responded independently to multi-step instructions. Pete was 4.0 years old and had an educational classification of developmental delay. Pete responded independently to multi-step instructions. Paul was 3.8 years old and had an educational classification of autism. Paul responded independently to one- and two-step instructions. Shawn was 5.5 years old and had an educational classification of developmental delay. Shawn responded independently to multi-step instructions. See Table 1 for additional information on the most recent standardized assessments and scores.

Sessions were conducted in the participant's typical education environment which consisted of a cubicle work area (roughly 2.5 m x 3 m) with a preschool sized table, two preschool sized chairs, and various educational items arranged in a small chest of drawers. Sessions were conducted during scheduled work times.

Table 1

Participants Ages and Assessment Results

	Age at start of study	Age at testing	Assessments	Scores
Pete	4.0	3.4	Vineland ABS-II WPPSI-III	Adequate SS = 81 PR=10
Ed	4.3	3.7	Vineland ABS-II WPPSI-III CELF Preschool 2	Moderately low SS = 59 PR = 0.3 Untestable
Paul	3.8	2.9	Vineland ABS-II WPPSI-III	Low SS = 55 ^a PR = 0.)
Shawn	5.5	4.3	CELF Preschool 2	PR = 0.5

Note. SS = Composite Standard Score; PR = Percentile Rank. The Vineland Adaptive Behavior Scale II, (VABS-II) is from Sparrow, Cicchetti, & Balla (2005); The Weschsler Preschool and Primary Scale of Intelligence, 3rd Edition (WPPSI-III) is from Wechsler (2002); The Clinical Evaluation of Language Fundamentals – 2 (CELF 2) is from Wiig, Second, & Semel (2004).

^aComposite score was not reported, verbal scores included instead.

Pre-Experimental Assessments

Before beginning the examination of behavioral momentum, appropriate target responses and reinforcers were identified. Target responses were selected from programs in each participant's current skill acquisition or maintenance curriculum. Additionally, a preference assessment was conducted with each participant to identify probable reinforcers to be included in the behavioral momentum examination.

Activity Identification

One activity was identified for each participant. The activities were used to measure rate of responding and persistence in the behavioral momentum examination. The experimenter consulted with each participant's current teacher to identify potential activities for inclusion in the study. Activities were selected based on two criteria. First, the activity was identified from the

participant's current curriculum (e.g., IEP objectives, IEP-related maintenance programs, or class wide curricular activities). Activities included play- or leisure-related activities only if it was currently an IEP or classroom curricular objective for a given student. Second, the participant must have had a history of engaging in the activity in the absence of teacher instruction for 3 to 5 min, not including an initial instruction to begin (e.g., "It's time to start working.").

Preference Assessment

A preference assessment was conducted with each participant to identify high-preference items that would be likely to function as reinforcers. Eight edible items were identified for each participant based on teachers' recommendations of potential reinforcers for the participant. Before beginning the preference assessment, each participant was allowed to sample each edible item twice, in random order. A paired-stimulus preference assessment (Fisher et al., 1992) was conducted to identify the reinforcers (i.e., items selected most often across the assessment). On each trial of the preference assessment, two items were presented simultaneously to the participants. Items were spaced about 25 cm apart and 30 cm in front of the participant. The participant was given 5 s to approach (i.e., touch) either item. Approaching one item resulted in the opportunity to consume the item and a selection response was scored. If the participant attempted to approach both items, the response was blocked, the items removed for 3 s, and represented one more time. If the participant again attempted to approach both items, the response was again blocked and the trial was scored as a *dual-approach*. If the participant did not approach either item within the 5 s, both items were removed for 3 s then represented with the verbal cue, "Pick one." If the participant again did not approach either item, both items were removed and the trial was scored as a *no response*.

Assessment sessions lasted for no more than 10 min to minimize potential effects of satiation and included as many trials as reasonably fit during that time (roughly 20-25 trials). Additional sessions were conducted no sooner than 1 hour after the previous session concluded

and were also conducted on separate days. Sessions continued until a full preference assessment was completed with the participant. Each participant was exposed to 56 trials comprising a complete 8-item paired-stimulus preference assessment, such that every item was presented with every other item twice and was presented on the left and right side the same number of times (see Appendix A for the preference assessment data sheet).

Independent Variable

The independent variable was the rate of reinforcement in two contexts (rich and lean). Two therapists were identified for each participant and randomly assigned to either the rich or lean context. For a given participant, each therapist remained assigned to the rich or lean context for the entire duration of the study. The therapists for the rich and lean contexts were both trained to deliver contingent reinforcement on a VI schedule. Additionally, both therapists were trained to deliver additional reinforcers according to a VT schedule, because both therapists would serve as the rich therapist for two participants and lean therapist for two participants. During sessions, the therapist wore one or two vibrating timers (MotivAider timing device) that were set to vibrate according to the current schedule to cue delivery of reinforcers (i.e., one timer was used during VI sessions and two timers were used during VI + VT sessions). The ratio of rich to lean rate of reinforcement was arranged such that the rate of reinforcement in the rich component was more than twice that of the lean component (per Dube & McIlvane, 2001).

The VI schedule was arranged to be as lean as possible while still arranging at least one to two reinforcer deliveries per lean session. Throughout the study, delivery of reinforcers (contingent or response independent) during each session was recorded to identify the obtained rates of reinforcement for each participant in the rich and lean contexts.

Treatment Integrity

An observer collected data on treatment integrity across all phases of the study. For the preference assessment, treatment integrity data were collected on at least 30% of trials for each participant. Treatment integrity data were collected on the correct delivery of items on each trial (i.e., were the correct items presented) and orientation of the items on each trial (i.e., right vs. left). During the behavioral momentum examination, treatment integrity data were collected on the inappropriate delivery of other potential reinforcers. Specifically, data were collected on therapist correctly withholding physical attention and verbal attention, not including the initial and closing statements. Physical attention was defined as any physical contact between the therapist's hands and any part of the participant (e.g., high fives, back pats, head rubs). Verbal attention was defined as any verbal interaction that was provided beyond statements outlined in procedures above. Inappropriate delivery of potential reinforcers was measured using a partial interval 10 s recording system, where a + was recorded for correct withholding of potential reinforcers and – was recorded for inappropriate delivery of additional verbal or physical attention. Procedures included providing refresher training on scheduled delivery of reinforcers and/or withholding additional potential reinforcers if treatment integrity had dropped below 90% for correct delivery of reinforcers or withholding of potential reinforcers for any session, however refresher training was not needed at any point. Treatment integrity for the preference assessment was collected on 36% of sessions for each participant (i.e., 20 trials) and was 100% across all participants and trials for both correct items presented and correct orientation. Treatment integrity data from the behavioral momentum experimental sessions are summarized in Table 2 for each participant.

Dependent Variable

The primary dependent variable was absolute rate of responding to the curricular activity. Specific response definitions depended on the curricular activities selected for each participant. In general, these definitions aligned with typical definitions of correct responses to educational activities. For Ed, the target activity was patterning, which consisted of Ed building a column of differently colored Unifix cubes that matched the pattern presented by the therapist (e.g., green, yellow, green, yellow, etc.). For Pete, the target activity was matching, which entailed Pete placing a given picture with an identical picture. For Paul, the target activity was puzzle building, in which Paul placed wooden puzzle pieces in corresponding spots on a wooden board. For Shawn, the target activity was sorting and included Paul placing items on pegs or in cups according to colors and shapes. For each participant, a response was scored when he released an item, such as letting go of a puzzle piece after placing it in a corresponding spot. Activities were selected to maximize the probability that participants would respond correctly and independently

Table 2

Treatment Integrity During Experimental Sessions, Expressed as Percent Agreement

	Percent of sessions	Verbal attn.		Physical attn.	
		Mean	Range	Mean	Range
Ed	60	100	97-100	100	100
Pete	33	100	100	100	100
Paul	33	100	97-100	100	97-100
Shawn	33	100	100	100	100

during sessions, yet data were collected on the total number of correct and incorrect responses to evaluate the effects of the independent variable on overall rates of correct and incorrect responding (see Appendix B for an example data sheet).

Relative persistence under disruption was examined by comparing the rate of responding under disruption to rate of responding during intervention in both contexts. Relative persistence was examined across-sessions using visual inspection of the data and proportion of intervention calculations. Visual inspection was used for both estimation of persistence (slope of data path in extinction) and absolute response rates (level of the data path). Proportion of intervention calculations were made by first calculating mean response rates across six sessions before disruption. Mean response rates were then calculated for the disruption sessions (e.g., six sessions during disruption phase). Finally, the proportion of intervention ratio was calculated by dividing the mean rate of responding during disruption by the mean rate of response during intervention (last six sessions). For example, in the rich context, the mean response rates of the six sessions of disruption is calculated then divided by the mean response rates of the final six sessions of intervention in the rich context resulting in the proportion of intervention for the rich context. Then the same calculations can be made for the lean context. The percentage calculations were used to supplement information gathered via visual inspection of the graphs.

Relative reinstatement following extinction provided information on the extent to which responding increased when participants were briefly reexposed to reinforcers presented during intervention. Relative reinstatement was examined using visual inspection of the graphs for each participant. In addition, relative reinstatement was examined using proportion of intervention calculations, such that the mean rate of responding in each context during reinstatement was divided by the mean rate of responding during the last six sessions of intervention.

Interobserver Agreement

Interobserver agreement was calculated on scoring of participant responding using data collected by two independent observers. A second observer collected data on participant responding during at least 30% of trials for the preference assessment for each participant and at least 30% of sessions across participants and for each phase of the behavioral momentum examination. An agreement in the preference assessment was defined as both observers scoring the same item as approached, dual approached, or not approached on a given trial. IOA for the preference assessment was calculated by dividing the number of agreements by the number of agreements plus disagreements and converting to a percentage. IOA for rate of response during a given session of the behavioral momentum examination was calculated by dividing the smaller number of observed responses by the larger number of observed responses and converting to a percentage. Interobserver agreement scores for each participant during the preference assessment and behavioral momentum experiment are presented in Table 3.

Table 3

IOA on Approach Responses During Preference Assessment Trials and Total Responses During Experimental Sessions, Expressed as Percent Agreement

	Preference assmt.			Experimental sessions		
	Percent of trials	Mean	Range	Percent of sessions	Mean	Range
Ed	37	100	100	30	98.1	91-100
Pete	37	100	100	30	99.6	95-100
Paul	37	100	100	30	98.3	92-100
Shawn	37	100	100	30	99.6	95-100

A second observer scored treatment integrity during the same experimental sessions scored for treatment integrity by the first observer (i.e., IOA calculated on treatment integrity for all sessions in which treatment integrity was collected). An agreement was defined as both observers scoring the same interval as appropriate or inappropriate. A disagreement was defined as one observer scoring an interval as appropriate and the other scoring the interval as inappropriate. Interobserver agreement on treatment integrity was calculated by dividing agreements by agreements plus disagreements and converting to a percentage. Interobserver agreement for treatment integrity was high across all sessions (see Table 4 for IOA on treatment integrity for each participant).

Table 4

IOA on Treatment Integrity, Expressed as Percent Agreement

	Verbal attn.		Physical attn.	
	Mean	Range	Mean	Range
Ed	100	100	100	100
Pete	100	100	100	100
Paul	100	100	100	97-100
Shawn	100	100	100	100

Experimental Conditions

General Procedures

Each session lasted 5 min (Ed, Pete, & Paul) or 3 min (Shawn). Shawn's session duration was set at 3 min, because his responding consistently decreased after 3 min during non-experimental work sessions. Sessions were conducted in pairs (i.e., one rich and one lean

context) with 2 min separating consecutive sessions (see Appendix C). Four to 12 sessions (i.e., two to six pairs of sessions) were conducted daily, 1 to 5 days per week. Pairs of sessions were separated by at least 2 min. The order of sessions was arranged such that on a given day, sessions were strictly alternated resulting in the same order of contexts within all pairs of sessions for that day. On the following day, the order of sessions within a pair of sessions was counterbalanced relative to the previous day (i.e., reversed; see Appendices D & E). The first session in extinction and reinstatement were counterbalanced across participants. For example, if one participant experienced Therapist A first in extinction and Therapist B first in reinstatement, then another participant experienced Therapist B first in extinction and Therapist A first in reinstatement. Sessions were video recorded to aid in scoring of sessions at a later time.

In each session, only one therapist (i.e., rich or lean therapist) was present and the other therapist was out of the participant's sight for the entirety of that session. The two therapists were familiar to the participant but interacted minimally with the participants outside of the experimental sessions. This arrangement was included to reduce the likelihood that extra-experimental contact between participants and therapists would reduce the differential persistence established during experimental sessions

During each session, the participant and therapist were seated on adjacent sides of a rectangular table (i.e., facing 90-degrees to one another). The area in front of the participant was free from all materials, except for items necessary for the identified curricular activity (see the second disruption phase for Pete and Paul for an exception). For each participant, the same materials were used throughout the study, regardless of phase or context. The session began with a brief, task-related instruction, such as, "It's time to do patterning." Reinforcers were delivered by the therapist according to the prescribed schedule, based on condition and context. The therapist placed the item on the work area in front of the participant. Delivery of reinforcers

followed the same procedure regardless of whether or not the delivery was according to the VI or VT schedule.

Therapists wore timing devices (MotivAider) to facilitate delivery of preferred items according to appropriate schedules. For VI schedules, the therapist delivered a preferred edible item to the participant after the first response following the end of the interval. For the VT schedules in the rich context, the therapist delivered a preferred item within 2 s of the scheduled time, regardless of participant behavior at that time. At the end of the session (i.e., 5 min or 3 min), the therapist made a closing statement, such as “We’re all done working.”

The VI reinforcement schedule for Ed and Pete was set at 120 s based on observations of several non-experimental work periods where each participant continued to respond to a task when reinforced on a VI 120 s schedule. Paul and Shawn did not consistently respond when reinforcement was provided on a VI 120 s schedule, but did respond consistently when reinforced on a VI 90 s schedule. Table 5 summarizes reinforcement arranged in each phase for all 4 participants.

Baseline

During baseline sessions, both therapists delivered preferred edible items contingent on responding according to the same VI schedule (e.g., 120 s). The specific baseline VI schedule was arranged to be as lean as possible but still result in about two reinforcer deliveries per session and responding across the entire session (i.e., responding does not extinguish). The only difference between sessions in baseline was the presence of one therapist or the other.

Intervention

During intervention, all procedures remained the same as in baseline, except one therapist now provided additional preferred edible items on a VT schedule while also delivering preferred items according to the same VI used in baseline. The VT schedule was set at 20 s, which arranged roughly 7 times the rate of reinforcement in the rich as compared to lean context for Ed

and Pete. The VT schedule in the rich context was also set at 20 s for Paul and Shawn, which arranged roughly 5.5 times the rate of reinforcement in the rich as compared to the lean context. This therapist and VI + VT schedule constitutes the rich context. The other therapist continued to deliver preferred items only according to the VI schedule used in baseline and represented the lean context. The intervention phase continued for at least 10 pairs of sessions (i.e., a pair of sessions includes one rich and one lean session) before moving to extinction.

Table 5

Reinforcement Contingencies for Each Participant, Phase, and Context

Participant	Context	Baseline	Intervention	Extinction	Reinstatement	Intervention 2	Distraction
Ed	Lean	VI 120 s	VI 120 s	EXT	1-2 free ^a		
	Rich	VI 120 s	VI 120 s VT 20 s	EXT	1-2 free ^a		
Pete	Lean	VI 120 s	VI 120 s	EXT	1-2 free ^b	VI 120 s	VI 120 s
	Rich	VI 120 s	VI 120 s VT 20 s	EXT	1-2 free ^b	VI 120s VT 20s	VI 120s VT 20s
Paul	Lean	VI 90 s	VI 90 s	EXT	2 free	VI 90s	VI 90s
	Rich	VI 90 s	VI 90 s VT 20 s	EXT	2 free	VI 90s VT 20s	VI 90s VT 20s
Shawn	Lean	VI 90 s	VI 90 s	EXT	2 free		
	Rich	VI 90 s	VI 90 s VT 20 s	EXT	2 free		

^afree reinforcer delivered at 5 s into first four reinstatement sessions and at 5 and 15 s in fifth and sixth reinstatement sessions

^bfree reinforcer delivered at 5 s into first two reinstatement sessions and at 5 and 15 s in third and fourth reinstatement sessions

Therapist Preference Probe

Following completion of the intervention phase, participants experienced a one-trial therapist preference probe to examine preference for one therapist relative to the other therapist. The probe was arranged by having the participant stand about 3 m in front of the therapists, who were spaced about 2 m apart with identical task materials and reinforcers present in front of each therapist. The participant was then told simultaneously by both therapists, "It's time to do [target activity]." Participant movement to one therapist or the other was recorded. Movement was defined as moving at least 1 m towards one therapist. If the participant did not move toward either therapist within 10 s, the therapists again delivered the simultaneous instruction. If still no response, the participant was told to, "Pick one." by a third, unfamiliar experimenter who was positioned behind the participant. The probe ended after movement towards one therapist or the other was observed or 1 min if no movement was observed.

Extinction (Disruption)

Extinction was arranged as the disruptor for all participants following intervention. During extinction, neither therapist delivered any reinforcers during the extinction sessions. All other materials and procedures were identical to intervention sessions. The extinction condition ended when responding decreases by at least 90% of intervention levels in both contexts or a total of 6 pairs of sessions had been conducted.

Reinstatement

Following the extinction condition, participants were exposed to a condition in which noncontingent reinforcement was delivered 5 s or 5 and 15 s into the session: Then no additional reinforcers were provided during that session for responding (i.e., extinction). Two to three sessions of reinstatement were conducted with each participant.

Intervention 2

Additional intervention and disruption phases were added for Pete and Paul to further examine persistence of educational responding. The second intervention phase included the same target response for each participant and arranged identical reinforcement schedules to the first intervention phase. The second intervention phase continued until stable levels of responding were seen in both contexts and the length of the phase was similar to the first intervention phase for a given participant.

Distraction (Disruption)

All procedures were identical to the second intervention phase except that potentially distracting stimulation was present instead of extinction. This distraction phase was added to examine potential differential persistence with an alternative form of disruption that has resulted in differential persistence in previous research on behavioral momentum with individuals with disabilities (e.g., Mace et al., 1990). The distraction phase included the presence of additional, alternative stimulation (i.e., a video for Pete; a toy, book, and video for Paul). Alternative stimulation was identified through consultation with the participants' classroom teacher and was selected to provide likely distraction from the target educational activity without resulting in complete suppression of the target response. The distraction phase continued for two to three pairs of sessions and ended with either differentiation in response rates and persistence or a maximum of three pairs of sessions.

Experimental Design

A multielement design was used to compare responding in each context across all phases for a given participant. The order of sessions was counterbalanced across days, contexts, and phases (for more information, see information under *General procedures* above). The multielement design allowed for comparison of the effects of the VI and VI + VT reinforcement

contingencies in each context relative to the other and the effect of the different reinforcement contingencies arranged during each phase and across phase changes. In addition, a multiple baseline across participants design was arranged to allow for further examination of patterns of responding across participants. Within the multiple baseline, different length baseline and intervention phases were arranged across participants to demonstrate changes in response patterns were due to the experimental manipulations and not extraneous variables. While baseline phases within a multiple baseline design typically include establishing stable (or deteriorating) responding, baseline in the current study was used to identify potential contextual biases, which, if present before intervention, would make interpreting later results difficult. Therefore similar response patterns in baseline indicated no bias and intervention could begin, regardless of stable rates of responding in baseline. In addition, the multiple baseline design allowed for demonstrations of experimental control over responding with each phase change on subsequent legs.

CHAPTER IV

RESULTS

Preference Assessment

The highest preference items for Ed, Paul, and Shawn were M&Ms. For Pete, the highest preference item was a cheese ball.

Obtained Rates of Reinforcement

Table 6 shows the arranged and obtained rates of reinforcement for each condition. Baseline was designed to arrange identical rates of reinforcement in both contexts. For three of four participants, rates of reinforcement in baseline conditions were similar (i.e., difference of .1

Table 6

Arranged and Obtained Rates of Reinforcement During Each Phase and Context

Participant	Context	Baseline	Intervention	Intervention 2	Distraction
		A [O]	A [O]	A [O]	A [O]
Ed	Lean	.5 [.4]	.5 [.5]		
	Rich	.5 [.5]	3.5 [2.9]		
Pete	Lean	.5 [.7]	.5 [.4]	.5 [.5]	.5 [.4]
	Rich	.5 [.4]	3.5 [2.7]	3.5 [2.7]	3.5 [3.4]
Paul	Lean	.7 [.6]	.7 [.5]	.7 [.6]	.7 [.7]
	Rich	.7 [.6]	3.7 [3.1]	3.7 [3.0]	3.7 [3.1]
Shawn	Lean	.7 [.6]	.7 [.6]		
	Rich	.7 [.5]	3.7 [2.9]		

Note. A = arranged rate of reinforcement; O = obtained rate of reinforcement.

or less, see Ed, Paul, Shawn). For Pete, the rate of reinforcement was 1.75 times higher in the lean context than the rich. During the intervention phase, rates of reinforcement were designed to be 7 times higher (Ed & Pete) and 5.5 times higher (Paul & Shawn) in the rich context than the lean context. Obtained rates of reinforcement were similar to arranged rates of reinforcement, ranging from roughly 6 to 8 times richer reinforcement in the rich context for Ed and Pete and roughly 4.5 to 6 times richer reinforcement in the rich context for Paul and Shawn.

Rates of Responding (Research Questions A & B)

Figure 1 shows the rates of responding in each session for each participant in both contexts across the entire study. In baseline, Ed responded at between 12 and 17 responses per min in both contexts, but showed no systematic difference in rates of responding, suggesting no contextual biases⁴ with identical schedules of reinforcement (Figure 1, top panel). When the intervention was initiated in both contexts, Ed's rates of responding decreased from baseline levels in the rich and lean contexts, with a greater immediate decrease in rates in the context associated with richer reinforcement. It is unclear however if this decrease was simply a continuation of the potential downward trend observed in baseline in both contexts. During intervention, Ed consistently responded at higher rates in the lean context as compared to the rich context. At the end of the intervention phase, Ed was responding at roughly 9 responses per min in the lean context and 6 responses per min in the rich context. When edible reinforcers were withheld for the target response (i.e., extinction⁵), Ed's rates of responding decreased in the context associated with leaner reinforcement but did not decrease in the context associated with

⁴ For all participants, there was no clear contextual bias demonstrated in baseline. It is worth noting that this conclusion does not demonstrate a complete absence of bias, it only demonstrates no bias when examined using rate measures. It is possible that contextual bias may have been present with some or all participants yet only evidenced with non-rate-based measures. However, if such biases were present, they would not be expected to be effect study results, because rate measures were used throughout the study.

⁵ While the term *extinction* is used here to describe the disruption conditions where edible items were no longer provided contingently or noncontingently during sessions, it is possible that there were other reinforcers contributing to the maintenance of the target response. Therefore, these procedures may not have functioned as a comprehensive extinction procedure for the target responses for some or all participants.

richer reinforcement. Ed's rates appeared to stabilize in both contexts at around 6 responses per min during extinction. When free reinforcers were provided at the beginning of the reinstatement sessions, Ed's rates of responding were similar to rates observed during disruption, 6 responses per min (i.e., no change in levels or trends).

In baseline, Pete responded somewhat variably between 6 and 8 responses per min in both contexts with no clear bias for one therapist versus the other (Figure 2, second panel from top). Across the entire intervention phase, Pete's responding remained stable at around 6 responses per min in both contexts (lean rate, $M = 6.0$; rich rate, $M = 5.8^6$). During extinction, Pete's rates of responding decreased similarly in both contexts to about 4 responses per min, though Pete responded at higher rates in the context associated with richer reinforcement in five of six pairs of disruption sessions. When reinstatement was implemented following extinction, Pete's responding increased in the context associated with richer reinforcement during intervention as compared to little or no increase in the context associated with learner reinforcement.

Pete experienced a second intervention and disruption phase about 1 month after the conclusion of the reinstatement phase. In the second intervention phase, Pete responded at similar levels in both contexts, though slightly higher in the lean context than the rich (lean rate, $M = 5.0$; rich rate, $M = 4.5$). When additional, alternative stimulation was present during distraction sessions (i.e., a children's movie), Pete's responding decreased to about 2.8 responses per min in the lean context as compared to 3.7 responses per minute in the rich context. Therefore his responding decreased less in the rich context as compared to the lean context.

In baseline, Paul responded at variable levels in both contexts with response rates ranging between 2 and 10 responses per min (Figure 1, third panel from top). While his rates of responding were highly variable, there was no clear systematic difference in rates of responding

⁶ Mean response rates are only presented for phases in which responding was stable across the entire phase, and thus presents a reasonable summary of the level of responding throughout the phase.

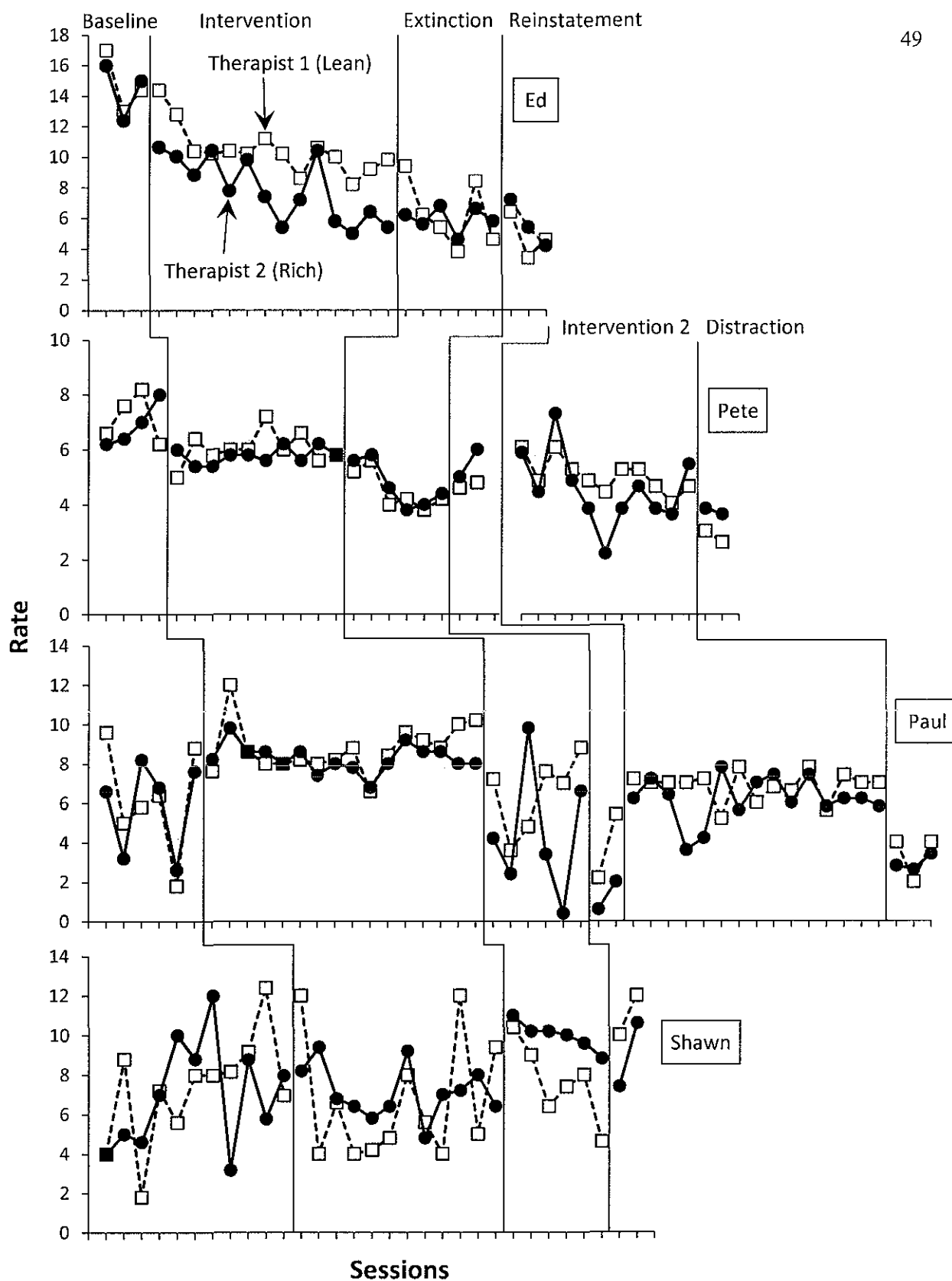


Figure 1. Participant response rates (responses per min) to educational tasks across all phases. Open squares represent the context with leaner reinforcement (VI only) during intervention. Closed circles represent the context with richer reinforcement (VI + VT) during intervention.

between contexts, suggesting no contextual bias before intervention. During intervention, Paul's rates of responding in both contexts were consistently higher and less variable than his rates of responding in both contexts during baseline. Paul's rates of responding during intervention immediately stabilized in both contexts at around 8.5 responses per min (lean rate $M = 8.8$; rich rate $M = 8.3$). During extinction, Paul's responding in both contexts became highly variable but was consistently higher in the context associated with leaner reinforcement during intervention. In addition, Paul's rates of responding initially decreased in both contexts but then increased throughout extinction in the context associated with leaner reinforcement. In contrast, Paul's rate of responding was lower and more variable in the context associated with richer reinforcement during intervention. In the reinstatement phase, Paul responded at higher rates in the context associated with leaner reinforcement during intervention as compared to the context associated with richer reinforcement. In the second intervention phase, Paul responded at about 6.5 responses per min in both contexts (lean rate, $M = 6.8$; rich rate, $M = 6.2$). When additional, alternative stimulation was available during distraction sessions (i.e., a toy, book, and children's movie), Paul's responding decreased to similar levels in both contexts (lean rate, $M = 3.3$; rich rate, $M = 2.9$).

In baseline, Shawn's rates of responding were variable and increased across the phase in both contexts. During the fifth through seventh pairs of baseline sessions, it appeared as if Shawn may have had a bias for Therapist 2 (see Figure 1, bottom panel), as evidenced by higher rate responding with Therapist 2 as compared to Therapist 1. However, this pattern did not continue when additional baseline sessions were completed. Thus, there was no clear contextual bias during Shawn's baseline. When intervention sessions began, Shawn's rates of responding became somewhat more stable, and he generally responded at higher rates in the rich context as compared to the lean context. When the extinction phase began, Shawn's responding immediately increased in both contexts, with higher rates observed in the context associated with

richer reinforcement as compared to leaner reinforcement during intervention. During the extinction phase, rates of responding decreased in both contexts, but rates of responding decreased more in the context associated with leaner reinforcement as compared to richer reinforcement. During reinstatement, Shawn's responding increased more in the context associated with leaner reinforcement as compared to rich and he responded at higher rates in the context associated with leaner reinforcement than richer reinforcement.

Persistence and Relapse (Research Questions C & D)

Figure 2 shows participants' responding summarized as proportion of intervention, which provides a measure of persistence and relapse relative to levels of responding during intervention in each context. During extinction, Ed's responding was more persistent in the context associated with richer reinforcement as compared to leaner reinforcement (Figure 2, top-left panel). In the reinstatement phase, Ed's responding increased to near intervention levels in the context associated with richer reinforcement (i.e., showed greater relapse), whereas his responding in the context associated with leaner reinforcement decreased to 50% of levels observed during intervention. During extinction, Pete's responding was slightly more persistent in the context associated with richer reinforcement as compared to the context associated with leaner reinforcement (Figure 2, top-right panel). During reinstatement, Pete's responding was at nearly 100% of intervention levels in the context associated with richer reinforcement during intervention. In contrast, Pete's responding was only at about 75% of levels observed during intervention in the context associated with leaner reinforcement. Under extinction, Paul's responding was more persistent in the context associated with leaner reinforcement during intervention, as compared to richer reinforcement (Figure 2, bottom-left panel). During the reinstatement phase, Paul's responding remained proportionately higher in the context associated with leaner reinforcement, although responding decreased in both contexts to even lower levels

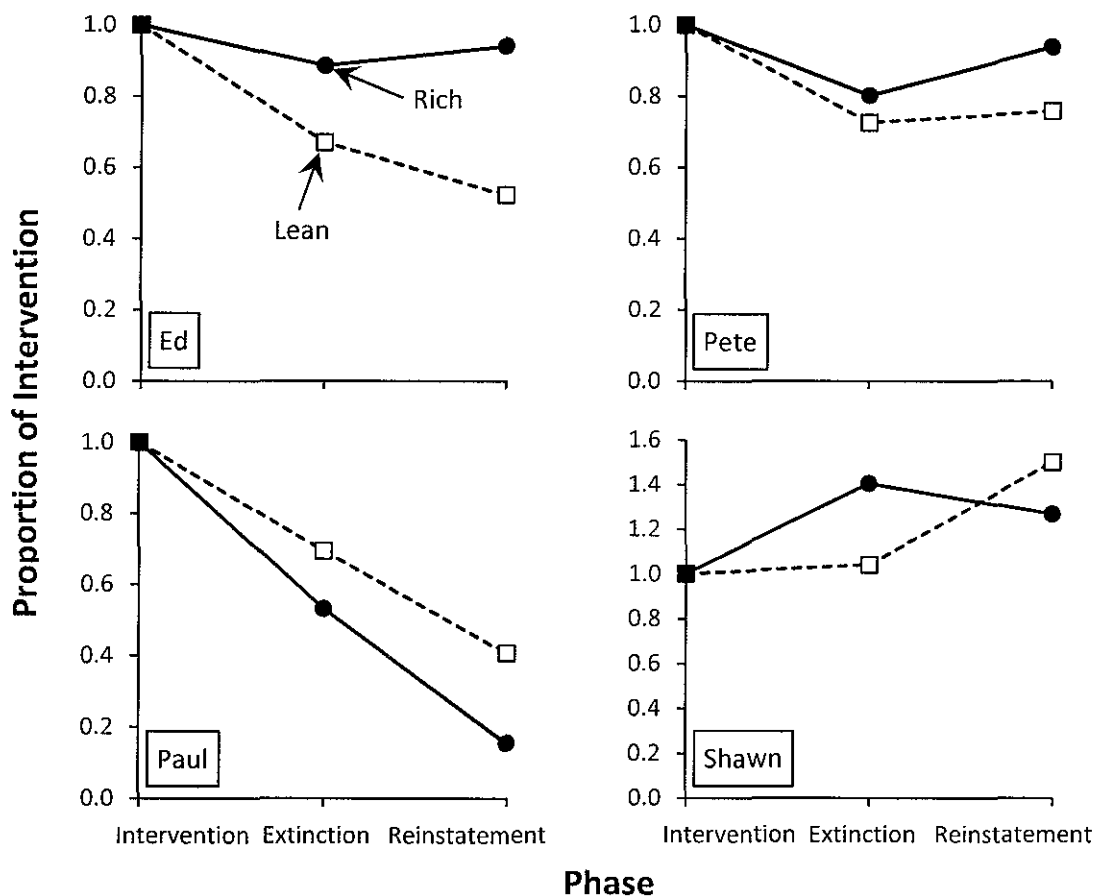


Figure 2. Persistence and reinstatement graphed as proportion of intervention for all participants. Means for intervention, extinction, and reinstatement phases calculated across the last 6 sessions, all 6 sessions, and all sessions, respectively.

than observed during extinction (i.e., did not show any relapse). During extinction, Shawn's responding was more persistent in the context associated with richer reinforcement (Figure 2, bottom-right panel) relative to leaner reinforcement during intervention. During reinstatement, Shawn's responding increased in the context associated with leaner reinforcement, whereas his responding decreased in the context associated with richer reinforcement. Throughout extinction and reinstatement, Shawn responded at above intervention levels in both contexts, as measured by proportion of intervention.

Figure 3 shows the results of Pete and Paul's second intervention and distraction phases, graphed as proportion of intervention. In the distraction phase, Pete's behavior was more

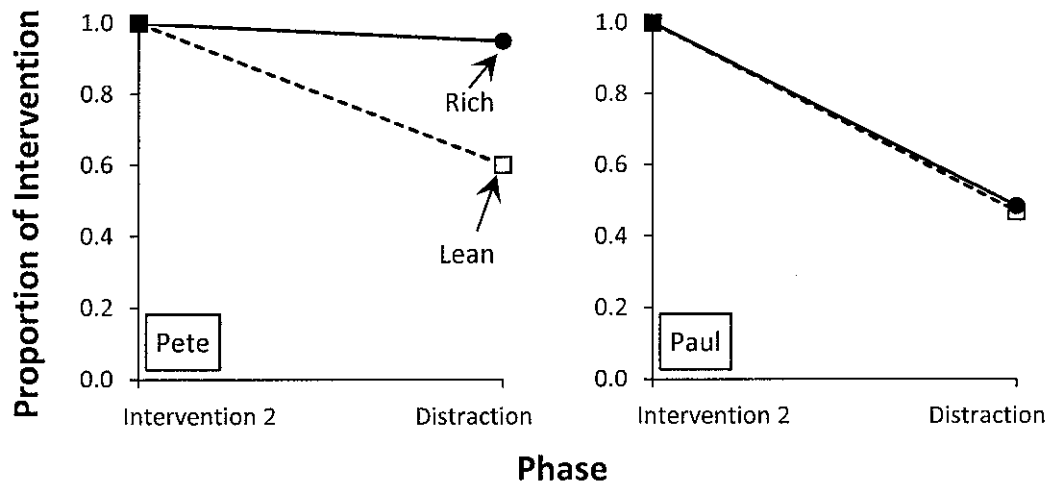


Figure 3. Persistence graphed as proportion of intervention for Pete and Paul during their second intervention and distraction phases. Intervention means calculated across the last 6 sessions of intervention and distraction means calculated across all distraction sessions for Pete and Paul.

persistent in the context associated with richer reinforcement during intervention as compared to leaner reinforcement (Figure 3, left panel). When Paul was distracted, his responding was similarly persistent in both contexts.

Rate and Persistence Summary

Figure 4 provides a summary of absolute and relative rates of responding in intervention, extinction, and reinstatement for each context and may be used to examine the effects on both rate (level of the data path) and persistence or relapse (slope of the data path⁷). Across the last six sessions of intervention in each context, Ed's mean rates of responding were higher in the lean context than the rich (Figure 4, top-left panel). In extinction, however, Ed's rates of responding decreased more in the context associated with leaner reinforcement than the context associated with richer reinforcement, such that mean response rates in extinction were similar in both contexts. In reinstatement, Ed's mean rate of responding was higher in the context associated

⁷ Steeper decreasing slopes show less persistent behavior and less relapse (in reality, no relapse is demonstrated if responding continues to decrease). Steeper increasing slopes show more persistent behavior and greater relapse.

with richer reinforcement than leaner reinforcement. Additionally, from extinction to reinstatement, Ed's mean rate of responding increased in the context associated with richer reinforcement but decreased in the context associated with leaner reinforcement. During the final six sessions of intervention in each context, Pete's responding was slightly higher in the lean context as compared to the rich context (Figure 4, top-right panel). In contrast, under extinction, Pete's rates of responding were now slightly higher in the context associated with richer reinforcement as compared to leaner reinforcement. During reinstatement, there was an even larger absolute difference in rates of responding, with rates higher in the context associated with richer reinforcement. Relative to extinction, Pete's mean rates of responding in reinstatement relapsed to a greater extent in the context associated with leaner reinforcement.

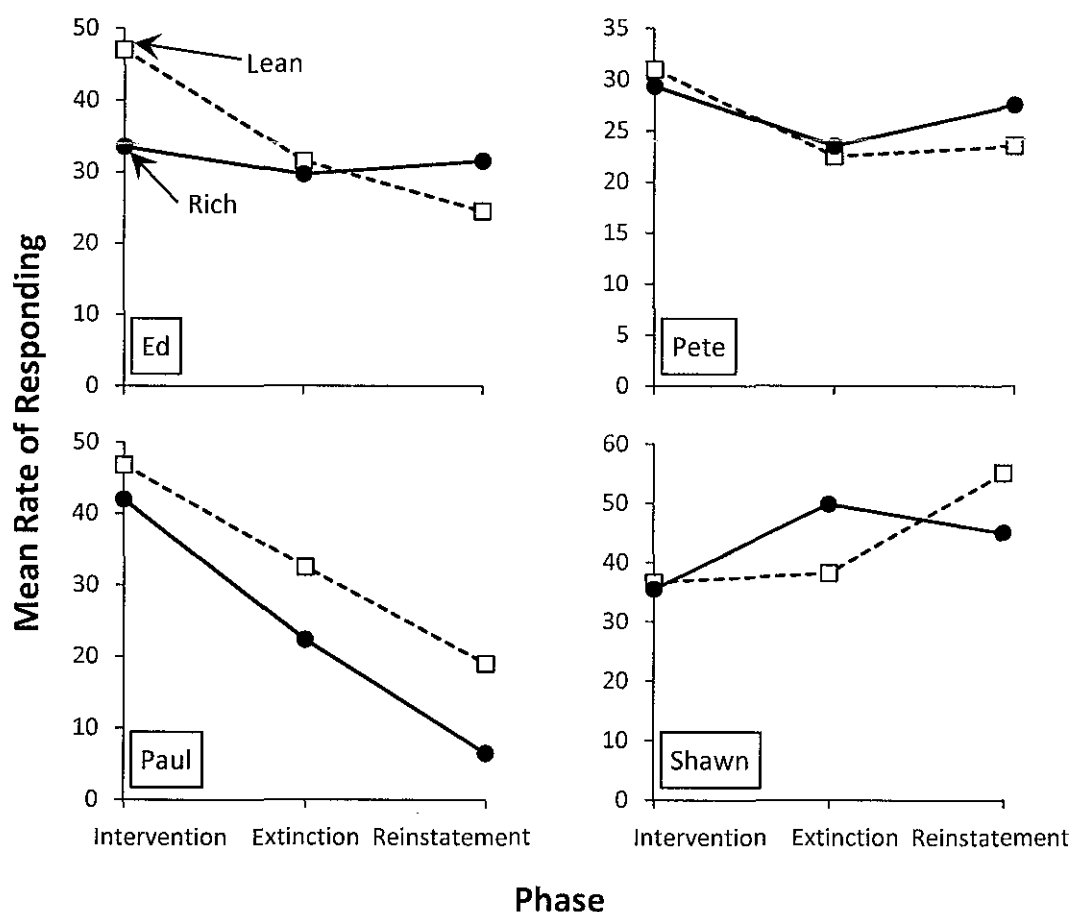


Figure 4. Mean rate of responding for all participant during the initial intervention, extinction, and reinstatement phases.

During the final sessions in intervention, Paul's mean response rates were relatively higher in the lean context as compared to the rich context (Figure 4, bottom-left panel). This pattern of greater mean rates of responding in the context associated with leaner reinforcement continued through the extinction and reinstatement phases. The similar decreasing slope of the data path for both contexts indicates similar persistence and lack of relapse.

Shawn's mean rate of responding was similar across the last 6 sessions of intervention in each context. Under extinction, however, Shawn's mean response rates were higher in the context associated with richer reinforcement than leaner reinforcement during intervention. During reinstatement, Shawn's mean response rates were higher in the context associated with leaner reinforcement relative to richer reinforcement. In addition, while mean response rates in the context associated with leaner reinforcement increased from extinction to reinstatement, mean rates decreased from extinction to reinstatement in the context associated with richer reinforcement.

Figure 5 summarizes the results for mean rates of responding during the second intervention and distraction phases for Pete and Paul. Pete's mean rate of responding was higher in the lean context at the end of the second intervention phase compared to the rich context (Figure 5, left panel). His responding was more persistent and he responded at higher rates in the rich context than the lean. During the second intervention phase, Paul responded at higher rates in the lean context than the rich (Figure 5, right panel). When distracted, Paul's mean response rate was again higher in the lean context than the rich, and the presence of distraction resulted in a similar decrease in mean rates of responding in the lean context as compared to the rich (as evidenced by similar slopes of the lines in the lean and rich contexts).

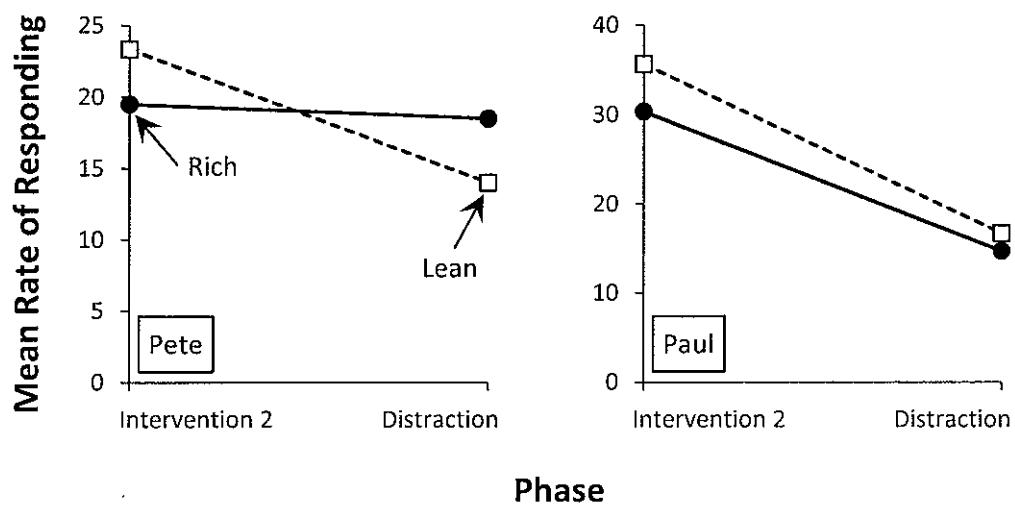


Figure 5. Mean rate of responding for Pete and Paul during their second intervention and distraction phases.

Contextual Preference

A single preference probe was conducted with each participant following the intervention phase. Ed, Paul, and Shawn all selected the therapist associated with richer reinforcement during intervention. Pete selected the therapist associated with leaner reinforcement during intervention.

CHAPTER V

DISCUSSION

Researchers examining behavioral momentum theory have noted responses that occur in a context associated with richer reinforcement will be more persistent when disrupted and relapse to a greater extent following extinction, relative to contexts associated with leaner reinforcement. Researchers have found this result regardless of relative rates of responding before disruption. Basic behavioral research has produced substantial evidence supporting behavioral momentum theory (see Nevin & Grace, 2000), yet relatively little applied or translational research has been published. The purpose of the current study was to investigate whether behavior momentum effects are detectable and clinically important in applied settings by examining the effects of rate of reinforcement on rate of responding before and after disruption, persistence of responding under disruption by extinction and distraction, and reinstatement of responding following extinction. To address these purposes, the current study arranged a total of six intervention and disruption phases and four relapse phases across four participants.

Participant responding can be examined in at least three ways; session by session response rates (i.e., Figure 1), proportion of intervention calculated using means calculated across consecutive sessions (i.e., Figures 2 & 3), and mean response rates calculated over blocks of sessions (i.e., Figures 4 & 5). Each method for presenting the data can provide a different picture of the results and may be more or less appropriate depending on the goals of the analysis. In addition, proportion of intervention data could be presented using a session by session format. However, in the current study, conclusions are identical for proportion of intervention data calculated as means within phases and session by session formats, so proportion of intervention data are only presented using phase means.

When the goal is to identify the presence of differential effects (i.e., greater or lesser persistence and relapse) across contexts, it is important to use a measure that is sensitive to subtle

but consistent effects. The proportion of intervention calculation will generally be more sensitive to differences than session by session rate data. In other words, the proportion of intervention calculation is appropriate if the goal is to identify the smallest *detectable* differences in persistence and relapse. For these reasons, this metric is commonly used in basic research on behavioral momentum. Specifically, any session to session variability before disruption is eliminated when means are calculated and therefore session by session data paths that may overlap to some extent appear noticeably different when comparing means. In addition, by describing change as a proportion of the rate in the previous phase, small but consistent differences in the initial level and amount of change in each context can combine to produce a proportional change statistic that can appear noticeably different (and even quite large) in one context and relatively small in the other context. Thus, by using proportion of intervention, subtle effects (i.e., minimal detectable differences) may be identified.

Identifying minimal detectable differences is key to identifying whether a given process (e.g., behavioral momentum) is occurring, but when examining the extent to which the process is relevant in practice, identifying clinically important effects is paramount. A clinically important effect is one that results in a socially relevant outcome, with social relevance often based on the observed increases or decreases in rates of the target response. In relation to the current research on persistence and relapse, a clinically important effect is evidenced when the changes are sufficiently large across contexts to indicate given outcomes may be preferable. Session by session data analysis generally provides an important index of clinically important effects, because it allows for examination of differences in response rates including session to session trends and variability. Thus, changes that may be associated with an intervention are seen relative to variability due to other sources. There is no established rubric for how much difference is clinically important, it is determined by people who are affected by the individual's

behavior (i.e., the individual behaving, their families, and others with whom they interact; Baer et al., 1968).

Results can also be examined using mean rates of responding, which allows for analyses of results with some characteristics of proportion of intervention and some characteristics of session by session rate data. A potential advantage of mean rate data is that they may provide an overview of the effects of the procedures on rate and also on change (persistence and relapse in this case). Therefore mean rate data may provide some information on both detectable differences (differences in slopes of the lines and presence of noticeable differences in mean rates) and clinical importance (socially relevant differences in levels of the means). However, because mean rate data removes intersession variability, using mean rate data should not serve as a complete substitute for session by session data analysis when evaluating clinically important effects.

Rates of Responding During Intervention and Disruption

Intervention

During intervention, mean rates of responding were lower in the context associated with contingent plus noncontingent reinforcement (rich context) in four of six intervention phases, as measured by mean response rates over the last six intervention sessions. (see Figure 4, Ed, Paul & Figure 5, Pete & Paul). This pattern of responding could be interpreted in at least two ways: (1) adding noncontingent reinforcers reduces the relative rate of reinforcement for the educational response (i.e., reinforcers contingent on the educational responses) in relation to the total reinforcement present and therefore the rate of the response decreases (Herrnstein, 1970; Rachlin & Baum, 1972) and (2) adding noncontingent reinforcers serves as an abolishing operation for the educational response (i.e., reduces the value of the consequence as a reinforcer for a given response; Laraway, Snyderski, Michael, & Poling, 2003).

Rate of responding in intervention phases can also be examined using session by session response rates (Figure 1). In the session by session data analysis, the effects of adding noncontingent reinforcement to one context are less clear because the somewhat subtle differences between contexts is seen relative to variability across sessions. In four out of six intervention phases (Figure 1, Intervention and Intervention 2 with Pete and Paul), the rates of responding in both contexts appear to be fairly similar and did not clearly represent a clinically important difference. Thus, based on these data, the noncontingent reinforcement procedure did not generally produce a clinically important effect for changing rates of responding.

Surprisingly, when noncontingent reinforcers were added to one context with Shawn (i.e., rich context), rates of responding in the rich context were often at or above rates of responding in the lean context (see Figure 1, bottom panel). This pattern of responding would not be expected for the reasons noted above. It is possible that Shawn's rate of responding was higher in the rich context, because his responding was based on a previously or newly learned rule relating these noncontingent reinforcers to his educational responding. This rule, if present, would functionally result in a higher rate of contingent reinforcement in the rich context. There were no clearly observable signs of rules or rule following, however, such as Shawn commenting about needing to work for the reinforcers, so this possibility remains speculative. These results highlight one potential challenge in working in translational or applied situations; i.e., participants may form and respond to verbal rules that differ from the experimentally arranged contingencies (see Hayes, Zettle, & Rosenfarb, 1989 for a discussion).

There are several potential reasons why subtle or no differences in response rates were observed in the rich and lean contexts during intervention sessions. First, it is possible that participants did not discriminate between the reinforcement contingencies or rates of reinforcement with therapists as context. On the other hand, it is possible that participants did, in fact, discriminate contexts but that the reinforcement arranged in each context did not appreciably

alter rates of responding: There is some evidence that participants were discriminating contexts. Specifically, mean rate data suggest that there was a consistent detectable difference in responding across contexts during most intervention phases (i.e., lower mean rates of responding in the rich context in five of six intervention phases). A second potential reason for lack of differentiation is the VT schedule of reinforcement may not have been dense enough to result in a clinically important difference in responding between contexts. This might be expected if the response had a long history of reinforcement and occurred at a relatively constant rate regardless of changes in reinforcement. Because the responses were familiar educational responses, participants had a history of engaging in the responses and reinforcement for performing the responses. In addition, participants engaged in a variety of other similar educational responses throughout their school days, and the majority of the educational responses occurred in their cubicle work areas. It is possible that these educational responses were members of one large response class. Thus, when additional noncontingent reinforcement was added for only one of many responses in the educational response class, the effect on rates of responding for the target response in the rich context may have been relatively small.

It is also possible that the target responses were maintained by multiple sources of reinforcement, such as automatic reinforcement in addition to therapist delivered edible reinforcers. If the responses were maintained by automatic reinforcement in addition to edible reinforcement, similar rates of responding in the rich and lean contexts could be interpreted in at least two ways. First, adding noncontingent edible reinforcers may not have appreciably increased the overall rate of reinforcement in the rich as compared to lean context. Thus, the total amount of reinforcement in the rich context was only slightly greater than in the lean context and may not have been meaningfully different for participants. An alternative interpretation is that adding noncontingent edible reinforcers did not reduce responding substantially because it only

reduced the motivation for the edible reinforcers and did not affect motivation for the automatic reinforcers that may also have maintained the response.

It is important to note, that while noncontingent reinforcement did not result in a clinically important decrease in rates in the rich context as compared to the lean context, this difference was not necessary for examination of relative persistence (i.e., effects consistent with behavioral momentum). Persistence is determined by the relative change in rate of responding before and during disruption, and therefore, absolute rates are only important for the calculation of persistence. However, differences in absolute rates before disruption are useful for interpreting results. In particular, if differential response rates are observed across contexts, it provides strong evidence that there were detectable effects of the experimental manipulations and participants were discriminating between contexts. When these differences are absent, clear differences must be evident in later phases to indicate participants may have discriminated contexts in earlier phases.

Disruption

Behavioral momentum theory predicts greater persistence in the context associated with richer reinforcement; yet *absolute rates* of responding under disruption are a function of both absolute rates during intervention and persistence in each context. Thus, it is not possible to make a priori predictions as to which context would be associated with higher absolute rates of responding during disruption. In the disruption phases (i.e., extinction and distraction) rates of responding were higher in the context associated with richer reinforcement in three of six cases (i.e., disruption phases; see Figures 4, Pete & Shawn; Figure 5, Pete). For the other three cases, rates of responding were higher in the context associated with leaner reinforcement (see Figure 4, Ed & Paul, Figure 5, Paul). At least two different methods could be reasonably used to compare rates of responding in each context during disruption, mean rates across the disruption phase and rates during the last disruption session in each context. While mean rates are used with these

data, it is worth noting that the ordinal outcome (i.e., higher vs. lower rates of responding) is identical when rates in the final disruption session data are used for all six disruption phases.

A similar analysis of rates of responding under disruption (extinction and distraction) can be conducted using the results of session by session rate measures shown in Figure 1. In this case, rates were noticeably higher in the context associated with richer reinforcement than leaner reinforcement for only two of six disruption sessions (extinction with Shawn and distraction with Pete). Whereas examination of Figure 4 suggests Pete's rate of responding was higher in the context associated with richer reinforcement during extinction (i.e., a detectable difference), this difference between responding is obscured by session to session variability in Figure 1 (i.e., there is not a clinically important difference).

In the current study, data analysis using mean response rates show a difference in response rates during disruption in three out of six cases, with higher responding in the context associated with richer reinforcement only present in two cases (distraction with Pete and extinction with Shawn). Examination of session by session response rates also indicates higher response rates in the context associated with richer reinforcement under disruption in only two of six cases (distraction with Pete and extinction with Shawn). Thus, in the current study, mean response rates and session by session data lead to similar conclusions when examining absolute response rates during disruption. Across participants, adding noncontingent reinforcement during intervention did not reliably result in higher response rates in one context or the other during disruption phases.

This result may not be surprising however, because the absolute rates of responding under disruption is related to levels of responding before disruption and persistence of the response. In addition, absolute rates of responding do not provide a direct test of behavioral momentum theory, because it is the relative change in rate that defines persistence, not absolute rate. However, in the current study, it is clear that persistence was not substantial enough to

result in consistently higher rates of responding under disruption in the context associated with richer reinforcement.

Persistence

Persistence describes the extent to which responding continues (i.e., resists change) when exposed to some disruptor and is calculated by dividing response rate during disruption by response rate before disruption. Thus, for the current analysis, it is the ratio of rate of responding during disruption to rate of responding before disruption, with a larger ratio indicating more persistence. Overall, greater persistence was detectable in the context associated with richer reinforcement for four of the six disruption phases (Figure 2, Ed, Pete, Shawn; Figure 3 Pete) and across three of four participants (Ed, Pete, Shawn). These results generally align with results predicted by behavioral momentum theory. In each case, greater persistence could not have been predicted by examining rates of responding before disruption: Participant responding was more persistent in the context associated with higher rates of reinforcement. However, this conclusion becomes tenuous upon closer examination of patterns of responding in the disruption phase.

Convincing demonstrations of differential persistence typically include rapid decreases in responding when exposed to extinction and ultimately result in responding that is at very low levels. In the current study however, rates of responding typically only decreased by about 10-40% of intervention levels. These results suggest that the extinction phase may not have arranged extinction for the educational responses and therefore did not provide a good test of behavioral momentum. It is possible that responding would have continued to decrease if additional sessions could have been conducted in extinction. For example, in previous basic research, responding in extinction was at or above baseline levels for at least the first 2 hours in extinction (Nevin et al., 1990, Exp. 2) or during the first four to six sessions of extinction (Nevin et al., Exp. 1). As time in extinction continued, responding then rapidly decreased to low levels. When extinction was implemented as a disruptor with two participants with disabilities, Mace et al. (2010, Exp. 3)

showed little or no decrease in inappropriate behavior across five sessions of disruption and responding rarely decreased by 50% from baseline levels. Therefore, results from Nevin et al. (Exp1 & 2) suggest responding in the current study may have decreased further with addition extinction sessions or longer time in extinction. However, the results of Mace et al. suggest that translational research on behavioral momentum, may not produce identical extinction effects to those obtained in basic research. Additional research is needed to further clarify the conditions in which extinction effects consistent with basic research may be obtained within translational or applied research on behavioral momentum theory.

It is possible that the effects during the extinction phase would have been different if extinction had resulted in near complete elimination of the target responses. For several reasons however, extinction phases were limited to a maximum of six sessions in each context. First, the participants were students in an intensive educational program for preschoolers with autism and therefore extensive extinction phases were undesirable as they would prolong participation and require removal from ongoing educational activities. Second, because the participants had a history of reinforcement with these particular educational activities and they engaged a variety of similar educational activities throughout their school days (i.e., discrete responses with intermittent reinforcement), it is possible that near complete extinction of the target response would not have occurred. Specifically, reinforcement provided within the classroom for similar activities may have been sufficient to maintain responding as part of a generalized academic-working response class, thereby making complete elimination of the target response unlikely. Finally, it is also possible that engaging in the target activities themselves had sufficient reinforcing properties (i.e., automatic reinforcement), so responding to the tasks could have continued for dozens of sessions, or more, despite withholding of therapist delivered edible reinforcers.

While the extinction phase did not result in a substantial reduction in these participants' responding, it did result in decreased rates of responding for three of four participants (see Figure 1, Ed, Pete, & Shawn) and therefore had disruptive effects. However, across these three participants, no consistent pattern emerged during extinction. Specifically, Ed's behavior was more persistent in the context associated with richer reinforcement, the opposite was true for Paul, and there was only a small difference in persistence in Pete's responding (see Figure 2).

Shawn's patterns of responding are somewhat unusual, because he responded at or above intervention levels during extinction (see Figure 1, bottom panel). In other words, his levels of responding did not decrease in the disruption phase relative to intervention and noticeably increased in the context associated with richer reinforcement. Across the extinction phase, his rates of responding were on a decreasing trend, yet his patterns of responding suggest that the extinction procedure was not an effective disruptor for his responding to the target task when implemented over six pairs of sessions. This pattern of responding does not allow for an appropriate test of behavioral momentum theory, and ultimately, his increases in responding in the extinction phase make it difficult to draw conclusions about persistence and the extent to which the effects are consistent with behavioral momentum theory.

It is worth noting that Paul's responding did decrease very quickly in the first two sessions in the extinction phase, with lower rates in the context associated with richer reinforcement (Figure 1, third panel down). Therefore, Paul's patterns of responding under disruption are consistent with the partial reinforcement extinction effect (PREE), which predicts greater behavioral persistence when behavior is reinforced on an intermittent versus continuous schedule. When considering the PREE, persistence is typically quantified by measuring the amount of time during which a response persists (i.e., time or sessions to some extinction criterion), as opposed to the relative rates of responding before and after disruption (i.e., proportion of baseline). Nevin, McLean, and Grace (2001) noted, however, that responses that

have been reinforced intermittently may be expected to persist for longer periods of time, because the change from intermittent reinforcement to extinction is less discriminable than the change from continuous (or relatively higher rate reinforcement) to extinction. This difference in the discriminability of the change from reinforcement to extinction has been called the generalization decrement (e.g., Nevin et al., 2001, see also Mackintosh, 1974). In other words, an individual contacts more omitted reinforcers in a shorter period of time in a context associated with higher rate as compared to lower rate reinforcement, and therefore a response extinguishes in a shorter amount of time in the high reinforcement rate context as the individual learns the current contingency. This situation would be analogous to two contexts with contingent reinforcement for responding in the presence of a discriminative stimulus (S^D). In Context A, the S^D is presented every 20 s and in Context B, the S^D is presented every 120 s. If extinction is implemented in each context for 2 min, then Context A would include six omitted reinforcers whereas Context B would include only one omitted reinforcer. Therefore, extinction would be expected to occur in fewer minutes in Context A, because there are many more opportunities per unit time to encounter the extinction condition.

Nevin and Grace (2005, Experiment 3) demonstrated that while extinction may occur quicker (e.g., in fewer minutes) following relatively rich reinforcement, responding is more persistent in the context associated with richer reinforcement, if it is measured by the number of omitted reinforcers needed to meet a given extinction criterion. While Nevin and Grace provided a potentially useful way to further examine Paul's results, it was difficult to conduct a similar analysis over multiple extinction sessions with Paul. The analysis was limited to only the initial part of the extinction phase, because he engaged in a variety of inappropriate behaviors (e.g., throwing materials and making loud vocalizations) after only 60 s had elapsed in the first extinction session with the therapist associated with richer reinforcement.⁸ During the first 60 s

⁸The emergence of a variety of inappropriate behaviors during extinction with Paul appears consistent with extinction induced challenging behavior (see Lerman, Iwata, & Wallace, 1999). Interestingly, these

of extinction in the context associated with richer reinforcement, Paul responded 11 times. During a typical 60 s period in the rich context during intervention, Paul accessed more than 3 reinforcers, on average (see Table 6). Therefore to access a similar number of reinforcers in the lean context (i.e., 3), Paul needed to respond for 360 s, which was equivalent to the first full session of extinction plus 60 s of the next session. When Paul's rate of responding under extinction is calculated over the first 360 s in the context associated with leaner reinforcement, his rate of responding was 6.7 responses per min. Interestingly, after 360 s of extinction in the context associated with leaner reinforcement, Paul also began to engage in inappropriate behavior similar to that observed in the context associated with richer reinforcement.

Figure 6 (left panel) shows Paul's responding in intervention and extinction graphed as proportion of intervention and calculated over the time that would have been necessary to access 3 reinforcers during intervention in each context (i.e., 360 s to access three reinforcers in the lean context and 60 s to access three reinforcers in the rich context). In the right panel of Figure 6, Paul's responding is graphed as rate of responding during omitted reinforcement intervals during extinction (i.e., the average time between subsequent reinforcers during intervention in each context – 120 s for lean and 20 s for rich conditions). These data show Paul's responding was lower rate in the rich context than the lean context during intervention, yet his responding was higher rate under extinction in the context associated with richer reinforcement as compared to the context associated with leaner reinforcement over the time needed to experience three omitted reinforcers. These data suggest Paul's responding was more persistent in the context associated with richer reinforcement, when taking into account the generalization decrement across the time typically needed to access three reinforcers in each context.

inappropriate behaviors were higher rate and more intense throughout extinction in the context associated with richer reinforcement. While the current study does not allow for a formal analysis, these patterns seems consistent with analyses of resurgence and behavioral momentum, in which placing a behavior on extinction that was previously reinforced on a richer schedule results in a relatively larger relapse of a second response (inappropriate behavior in this case, see Podlesnik & Shahan, 2009 for research including resurgence and behavioral momentum).

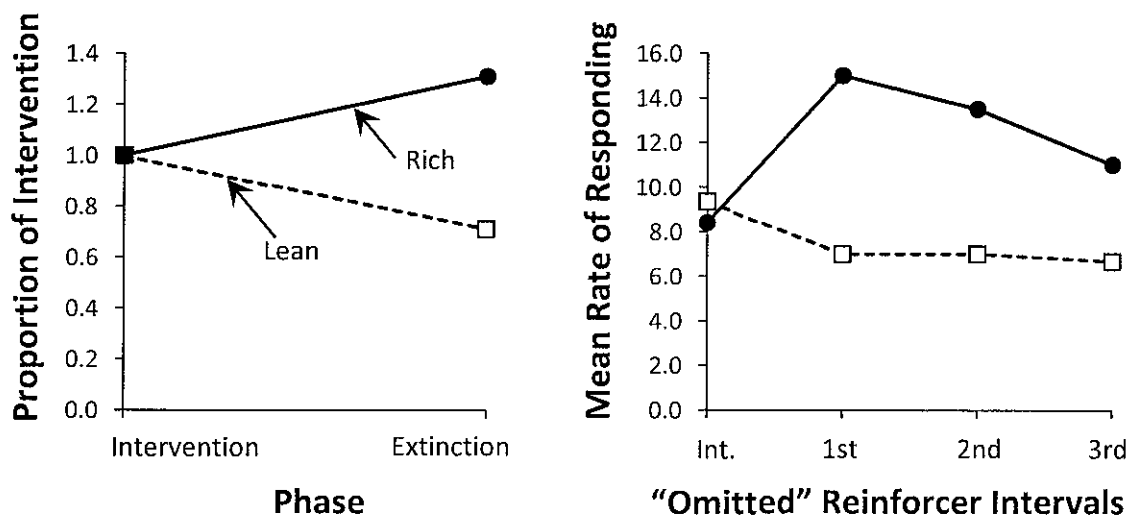


Figure 6. Proportion of Intervention and mean rate of responding for Paul, adjusted for generalization decrement. Omitted reinforcement intervals are 120 s and 20 s for the contexts associated with lean and rich reinforcement, respectively.

This analysis indicates there were detectable differences (i.e., greater persistence) in the first few sessions of extinction in the context associated with richer as compared to leaner reinforcement. Furthermore, Paul's patterns of responding at the end of the intervention phase suggest that he was discriminating between contexts, though it is unclear for how many sessions he was discriminating between contexts. Across the extinction phase however, Paul continued to respond more in the context associated with leaner reinforcement. Overall, it is difficult to make any strong conclusions regarding Paul's results due in part to the limitations noted above and the general increase in inappropriate behavior in the extinction phase.

While the potential role of the generalization decrement was only examined with Paul, similar patterns of responding may be likely any time responding is disrupted by extinction in two contexts with different rates of reinforcement. By examining results and taking the generalization decrement into account, the analysis may become more sensitive to differential effects. However, when examining effects within one or only a subset of sessions at the beginning of disruption, results may also be further removed from analyses that are essential to determine clinical

importance (this is similar to the difference between examining results based on mean rates as compared to session by session results).

Pete and Paul experienced a second intervention and disruption phase (i.e., distraction). Responding occurred at similar rates in both contexts during intervention, and therefore is subject to the same limitations noted in the first intervention phases. During the distraction phase, responding decreased in both contexts with both participants. With Paul, however, responding occurred at similar rates in both contexts during intervention and also during distraction. Therefore is unclear if Paul discriminated between contexts during the second intervention and distraction phases. Pete's rates of responding decreased by about 40% when distraction was added to the lean context, relative to intervention levels. In the rich context, Pete's responding was near intervention levels when distracted. Thus, the relatively large and immediate reductions in response rates during distraction does suggest that the particular distracter effectively reduced his responding in the lean context while his responding was minimally disrupted in the rich context. However, Pete responded at similar levels in both contexts during intervention, and therefore, it is unclear if he was discriminating between contexts during intervention. In contrast, because Pete's rates of responding were slightly lower in the rich context as compared to the lean context during the second intervention phase, he appears to have been discriminating between contexts before entering the distraction phase.

In sum, responding during extinction did not result in sustained and substantial decreases in responding for any participant. This pattern of responding in disruption suggests extinction was not a particularly powerful disruptor for these participants and responses. It is possible that participants' histories with the responses were sufficient to require additional time in extinction, and as such, more extensive extinction phases may have resulted in lower rates of responding. Alternatively, it is possible that other sources of reinforcement contributed to maintenance of responding and reduced the overall disruptive effect of withholding edible items. Relative to

distraction, participant responding may have decreased more if different items had been present as distracters. To show convincing evidence of differential persistence, researchers must use disruptors that substantially reduce the target response in at least two contexts and smaller reductions must occur in one context versus another. In the current study, substantial decreases were typically not observed and therefore, do not allow for strong evaluations of these data relative to behavioral momentum theory.

Reinstatement

As noted above, Paul's responding continued to decrease across extinction and showed no relapse when reexposed to reinforcers in either context (i.e., his responding did not reinstate). Shawn's responding was not disrupted during the extinction phase and therefore could not *reinstate*. Therefore, it impossible to interpret Shawn's results relative to behavioral momentum theory and relapse. For the remaining two participants, the context associated with richer reinforcement resulted in proportionately and absolutely higher rates of responding when reexposed to brief noncontingent reinforcement at the beginning of sessions (Figures 2 & 4, Ed and Pete). However, understanding these results relative to previous research on reinstatement is difficult, because typical reinstatement procedures include implementing extinction conditions until a specific extinction criterion has been met (e.g., below 10% of baseline in both contexts for two sessions, Podlesnik & Shahan, 2009). Because the target response was not substantially reduced with any participant before moving to the reinstatement phase, conclusions on reinstatement must be reserved for future research.

Preference

During the preference probes, three of the four participants selected the therapist associated with richer reinforcement during intervention and showed more persistent responding in the context associated with richer reinforcement (including the reanalysis of Paul's data taking

into account the generalization decrement). Nevin and Grace (2000) have suggested that preference and persistence provide converging measures of response strength. Given the lack of clear effects on persistence, however, comparisons between preference and persistence cannot be made here.

The preference probe procedure should be considered an untested yet logical procedure. All participants had a history of choosing between preferred items by making a selection response, yet the preference probe procedure was novel for all participants. Ed and Paul responded immediately during the preference probe by approaching the rich therapist and beginning to interact with the task materials, suggesting their response was under appropriate control (i.e., control of the simultaneous instruction to begin working and history with the two therapists, educational activities, and associated reinforcement). Pete and Shawn, however, did not respond immediately to the therapists' simultaneous instructions to begin working. It may be that Pete and Shawn's selection responses were under the control of some unknown variables, for example, side preference. Attempts were made to control for other potential sources of control by ensuring the educational materials, edible reinforcers, and chairs all looked identical from the participants' perspective.

Contextual Cues

Differential persistence requires the establishment of at least two contexts with different richness of reinforcement. In contrast to previous research that typically arranged context using arbitrary color cues, the current study arranged context using two different staff members. The possibility that staff can function as context is particularly relevant when considering interventions for persons with moderate to profound disabilities. Individuals with disabilities interact with a variety of different people throughout their day, such as parents, siblings, teachers, paraprofessionals, occupational and physical therapists, school support personnel, vocational support staff or coworkers, and classmates. Given the potentially large number of people

interacting with these individuals, it is likely that different people provide different richness of reinforcement, even when they are supposed to be providing the same or similar consequences for behavior (e.g., when implementing behavioral or educational support plans). Because individuals with disabilities likely interact with a variety of caregivers who serve as sources of reinforcement, it seems likely that caregivers are a primary determiner of context. However, it is difficult to evaluate the role of staff as context in the current research, because the effects of disruption were not robust and clear differentiation of responding was not evidenced in any phase. Additional research is needed to determine the conditions under which staff function as context in the behavioral momentum model. Producing differential persistence with applied contextual variables, such as staff as context, will be essential to determining whether behavioral momentum theory can have important clinical implications.

The multielement design may be a particularly useful method for applied research on behavioral momentum theory, because it appears to closely approximate some real world situations that individuals with disabilities encounter. For example a student may work on educational activities with a variety of paraprofessionals. However, while approximating real-world situations, the multielement design used in this study may have had unintended effects. When noncontingent reinforcement was added to one context during intervention, participant responding in both contexts appears to have become more stable than in baseline (see Paul's data in Figure 1 for the clearest example of this effect). This effect may indicate that the contexts are not independent and overall results are due in part to an interaction between contexts. In other words, concurrent changes in participant responding in both contexts may indicate lack of discrimination between contexts in the multielement design. It is possible participants would have discriminated contexts better if persistence was examined with contexts arranged in blocks of session (i.e., as in a reversal design with appropriate counterbalancing). Discrimination may

have been more likely in a reversal design, for example, because there would be more time between sessions within each context (i.e., with rich and lean reinforcement)..

Target Responses

The current study included responses that were part of familiar, educational activities for preschoolers with autism. The specific educational responses had a history of reinforcement under a variety of stimulus situations, such as with several different educators and at different times of day. In addition, participants continued to engage in similar educational activities with a variety of educators and reinforcers over the duration of the study. Given this history, it is possible different therapists were not salient contextual features relative to the particular educational responses and therefore could not produce effects consistent with behavioral momentum theory. For example, because therapists were primarily deliverers of reinforcers, participants may not have paid particular attention to which therapist was delivering edible reinforcers. Instead, the research sessions may have occurred in a single, large context that could simply be described as *working at school*. It is then possible that responses occurred at similar rates and with similar persistence within the *working at school* context. Thus, brief changes in therapists may not have been resulted in two separate contexts and therefore effects consistent with momentum could not be produced. Finally, it is possible participant responding was largely maintained by automatic reinforcement and therefore manipulation of the rates of edible reinforcement resulted in only small relative differences in overall rates of reinforcement. Thus, little change across phases and differentiation across rate of programmed reinforcement would be expected.

Limitations and Future Directions

The current study has several limitations. Two primary limitations are (1) the generally limited effect of the disruptors (i.e., extinction and distraction) on the level of target responses,

which could be due to the particular disruptor, the particular response, or a combination of disruptor and response and (2) a potential lack of discrimination of contexts. In the current study, extinction was limited to a maximum of six pairs of sessions because participants could not be removed from educational programming for extended periods of time. Unfortunately, participant responding did not consistently decrease to very low levels during these six pairs of sessions (although as was discussed above, the patterns observed in extinction appear similar to patterns observed during extinction in previous research.) Research on behavioral momentum requires demonstration of strong disruptive effects in order to test predictions of differential persistence; so if rapid reductions in the target response are not found, future researchers should conduct more extensive extinction sessions than were included here. For some responses, it may be necessary to conduct lengthy extinction phases to see large reductions in the target response.

It is possible that some educationally relevant responses may be maintained by automatic reinforcement or may function as elements of a larger response class that is reinforced in numerous contexts; therefore withholding therapist delivered reinforcers may not produce extinction. When effective extinction is arranged, stronger conclusions may then be drawn about the role of behavioral momentum in applied situations and the potential role of other variables, such as staff as context for differential persistence and relapse. Researchers may then conduct follow-up research incorporating responses with more extensive histories (i.e., familiar responses) to replicate earlier findings. If familiar educational responses cannot be reduced to very low levels under extinction, future researchers may need to include alternative tasks that are less likely to be maintained by automatic reinforcement or part of a large educational response class. By including alternative responses, researchers may increase the likelihood of identifying effects consistent with behavioral momentum, because the responses may be more likely to result in rapid and large reductions under extinction. To effectively address this limitation, researchers may need to include additional preexperimental assessments to successfully identify effective

disruptors and appropriate responses for research on behavioral momentum in applied situations (i.e., including applied settings and socially relevant responses).

In addition to participant responding being only moderately disrupted during extinction and distraction (i.e., a small absolute effect, see first limitation), persistence under disruption was relatively similar across contexts in many cases (i.e., a small relative effect). This lack of differentiation may suggest little or no discrimination of contexts. It is possible that therapists were not sufficiently salient as contextual stimuli using the current procedural arrangements (e.g., session duration, intervention phase length, minimal therapist interaction with participants). For example, therapists had relatively little interaction with participants during intervention sessions (i.e., their primary role was to deliver edible reinforcers) and therefore may not have been an important contextual stimulus for participants. It may be necessary to increase the saliency of therapists within each context to arrange differential persistence. For example, if responses decrease during disruption but there are still little or no differential effects across contexts, it may be necessary to increase contextual salience, such as by having each therapist deliver tangible reinforcement paired with praise statements. It may also be necessary to have longer intervention phases (i.e., more extensive contact with the therapist-reinforcement rate relation) before differential effects may be observed under disruption.

In addition to selecting target responses and arranging effective extinction, future research should further examine the relation between preference and persistence. Given the delays observed with Pete and Shawn's selection responses, the preference probe procedure should be revised in future research. In the current study the preference probes were conducted in the main classroom area but experimental sessions were conducted in participant cubicle work areas. It is possible that this change in location affected results of the preference probe, because it may have functioned as a sufficiently different context from where rich and lean contexts were arranged (i.e., with different therapists in participants' education cubicles). It is therefore

possible that preference for therapists in the classroom area was different than preference for therapists in the cubicle area. In addition, the current preference probe procedure included only one probe trial to observe a participant's selection response. By presenting only one trial, it is possible that participant selection responses were under the control of an extraneous variable (e.g., side preference, preference for a particular position at the table, or preference for one general area of the room). Alternatively, if multiple probe trials are conducted, non-essential aspects of the probe arrangement can be counterbalanced across trials (e.g., therapist orientation). By using counterbalancing strategies across multiple trials, researchers may better measure participant preference or identify extraneous variables that control responding and make further revisions to the preference probe procedure. Thus, an enhanced preference probe procedure should include conducting several preference probes arranged identically to intervention sessions. However, therapists will need to be positioned identically across intervention sessions to ensure they are the only contextual cue. Therefore, preference probes must be structured such that neither therapist is in the exact location used during intervention sessions, otherwise participant selection responses may be under the control of therapist location, not association with richer or leaner reinforcement. Thus, during the preference probes, each therapist could be seated equidistant from their position during intervention sessions and their relative positions should be counterbalanced across probes⁹. An enhanced preference probe procedure will be important to better assess preference for therapists following rich and lean reinforcement and may allow for further examination of the relation between preference and persistence as related to behavioral momentum theory.

Regarding reinstatement procedures, noncontingent delivery of reinforcers at the beginning of reinstatement sessions may be more similar to the rich intervention sessions than the

⁹ Alternatively, therapist location could vary randomly across all intervention preference probe sessions, such that the only reliable cue for context is therapist. If therapists' locations are varied randomly across intervention sessions, then therapist location during preference probes would be less problematic as long as participants were able to make the same selection response for each therapist.

lean intervention sessions. Just as reinstatement conditions may include delivery of noncontingent reinforcers at the beginning of the session; it is likely common for sessions in rich contexts during intervention to include delivery of several noncontingent reinforcers at the beginning of the session. Therefore, it is possible that responding may increase more in the context associated with richer reinforcement due to this contextual similarity and not increased response strength consistent with behavioral momentum theory. Future researchers should examine reinstatement with noncontingent reinforcers and also include reinstatement with contingent reinforcers at the beginning of sessions (similar to Podlesnik & Shahan, 2009).

Another limitation is the overall similarity in the length of intervention phases across participants. Each participant experienced between 10 and 16 pairs of intervention sessions, and therefore it is possible that the effects observed during disruption and reinstatement phases would have been different with greater or fewer sessions in a given phase of the current study. It may be particularly important to have longer phases so participants have sufficient time to discriminate between contexts before experiencing disruption. Mace and colleagues (1990) found greater persistence in the context previously associated with richer reinforcement after exposing participants to 10 to 14 pairs of sessions with different rates of reinforcement, yet Dube and McIlvane (2001) did not find differential persistence with one participant after eight pairs of sessions, despite differential rates of reinforcement. Therefore it is possible that a minimum number of sessions must be spent under the reinforcement conditions to observe detectable differences in persistence (as noted above, longer exposure to contexts and contingencies may also be important for discriminability across contexts). Similarly, it is possible that even greater numbers of sessions may result in greater differential persistence across contexts. Given the general lack of clear effects in the current research, it seems particularly important for future

researchers to determine if longer exposure to rich and lean contexts results in larger differences in responding, both during intervention and under disruption.¹⁰

A final potential limitation is the inclusion of interval reinforcement schedules. The advantage of interval reinforcement schedules for research on behavioral momentum is, barring very low-rate behavior, the experimenter controls the rates of reinforcement in each context. This is contrasted to ratio schedules, in which participants control the rate of reinforcement, because faster or slower responding results in higher or lower rate reinforcement. While interval schedules have benefits for research on behavioral momentum, they may not sufficiently approximate reinforcement contingencies in applied settings. There is preliminary evidence that interval schedules are both more preferred and result in more persistent behavior than ratio schedules (Nevin, Grace, Holland, & McLean, 2001), though Nevin et al. concluded that the differences between ratio and interval reinforced behavior are very small compared to the differences in persistence observed when rates of reinforcement are dissimilar. To date, however, it is unclear if interval schedules are sufficiently similar to contingencies common in applied situations to allow for generalization of these findings to behaviors reinforced on ratio schedules. Translational and applied researchers should increasingly examine persistence when ratio schedules are used (see Dube & McIlvane, 2001 for an example of translational research using ratio schedules of reinforcement).

Conclusions

Individuals with disabilities often receive interventions that include adding reinforcement to a context in order to increase or decrease the rate of a target behavior. Behavioral momentum theory predicts that some common procedures in applied settings may have desirable effects on rate but not on persistence of responding. However, there is currently little research demonstrating clinically important differences when commonly used interventions are compared

¹⁰ Length of exposure to contexts could be measured as total time in each context or number of sessions.

to procedures designed to address both rate and persistence in applied situations (i.e., with applied contextual variables, socially relevant responses, typical intervention strategies and parameters, commonly encountered disruptors, and clinically important differences in outcomes across contexts). Additional translational research is needed to clarify the ways in which behavioral momentum theory may predict outcomes in applied situations. However, the translational process can be challenging, because it requires clear demonstration that the relevant basic processes are operating while incorporating progressively more applied features (i.e., contexts, responses, interventions, disruptors).

The current study highlights some of the methodological challenges relevant to translational research on behavioral momentum. Researchers must include responses that are amenable to disruption, and whenever possible, researchers should select disruptors that replicate or approximate likely disruptive conditions in applied situations for a given target response. Contexts should be arranged using potential applied contextual variables and attempts should be made to ensure participants discriminate contexts before introducing disruption. Ideally, discrimination will be evident in patterns of responding before disruption (e.g., the target response occurs at clearly different response rates across contexts), but some interventions may not result in clearly differential response rates before disruption (e.g., increasing magnitude of reinforcers to increase persistence of desirable responses may not appreciably change response rates). Therefore researchers may need to arrange more time in each context during intervention to increase the likelihood participants will discriminate contexts before beginning disruption. Alternatively, researchers may find that they need to add in additional contextual features to facilitate discrimination. When necessary, these additional contextual features should be selected because they are common in applied situations. If researchers plan to disrupt using extinction, they should select responses that are amenable to such procedures and be prepared to extend the extinction phase until substantial reductions are observed. Low levels of responding during

extinction are essential to address translational research on reinstatement and behavioral momentum theory. Finally, care must be taken when designing procedures to assess contextual preference. Specifically, research must balance the challenges related to establishing discriminable and socially-relevant contexts while effectively assessing preference without introducing contextual changes that may bias participant responding.

Behavioral momentum theory may have important implications for practice, but to date, there are few translational or applied studies. As research in this area continues, it may become clear that concerns related to behavioral momentum can be manifest in applied situations and to socially important levels. In the current study, however, it is difficult to interpret results given several limitations. Differential effects during intervention and disruption were generally small and therefore it is unclear if lack of effects is due to one or more variables. Specifically, the lack of clear effects could be due to the particular responses used, difficulty in discriminating context when defined by therapists, or generally small decreases in responding under disruption. Applied researchers should continue to examine with the implications of behavioral momentum theory, with a particular focus on whether richer reinforcement actually leads to clinically important differences in persistence and relapse.

REFERENCES

- Ahearn, W. H., Clark, K. M., Gardenier, N. C., Chung, B. I., & Dube, W. V. (2003). Persistence of stereotypic behavior: Examining the effects of external reinforcers. *Journal of Applied Behavior Analysis, 36*, 439-448.
- Alberto, P. A., & Troutman, A. C. (2006). *Applied behavior analysis for teachers*. Upper Saddle River, NJ: Pearson Merrill Prentice Hall.
- Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis, 1*, 91-97.
- Blackman, D. E. (1968). Response rate, reinforcement frequency, and conditioned suppression. *Journal of the Experimental Analysis of Behavior, 11*, 503-516.
- Bouzas, A. (1978). The relative law of effect: Effects of shock intensity on response strength in multiple schedules. *Journal of the Experimental Analysis of Behavior, 30*, 307-314.
- Cohen, S. L. (1996). Behavioral momentum of typing behavior in college students. *Journal of Behavior Analysis and Therapy, 1*, 36-51.
- Cohen, S. L., Riley, D. S., & Weigle, P. A. (1993). Tests of behavior momentum in simple and multiple schedules with rats and pigeons. *Journal of the Experimental Analysis of Behavior, 60*, 255-291.
- Cooper, J. O., Heron, T. E., & Heward, W. L. (Ed.). (2007). *Applied behavior analysis* (2nd ed.). Upper Saddle River, NJ: Pearson Education.
- Dube, W. V., & McIlvane, W. J. (2001). Behavioral momentum in computer-presented discriminations in individuals with severe mental retardation. *Journal of the Experimental Analysis of Behavior, 75*, 15-23.
- Dube, W. V., & McIlvane, W. J. (2002). Reinforcer rate and stimulus control in discrimination reversal learning. *The Psychological Record, 52*, 405-416.

- Dube, W. V., McIlvane, W. J., Mazzitelli, K., & McNamara, B. (2003). Reinforcer rate effects and behavioral momentum in individuals with developmental disabilities. *American Journal on Mental Retardation*, 108, 134-143.
- Fath, S. J., Fields, L., Malott, M. K., & Grossett, D. (1983). Response rate, latency, and resistance to change. *Journal of the Experimental Analysis of Behavior*, 39, 267-274.
- Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis*, 25, 491-498.
- Grimes, J. A., & Shull, R. L. (2001). Response independent mild delivery enhances persistence of pellet-reinforced lever pressing in rats. *Journal of the Experimental Analysis of Behavior*, 76, 179-194.
- Harper, D. N. (1996). Response-independent food delivery and behavioral resistance to change. *Journal of the Experimental Analysis of Behavior*, 65, 549-560.
- Hayes, S. C., Zettle, R. D., & Rosenfarb, I. (1989). Rule-following. In S. C. Hayes (Ed.), *Rule-governed behavior: Cognition, contingencies, and instructional control* (pp. 191-220). New York, NY: Plenum Press.
- Herrnstein, R. J. (1970). On the law of effect. *Journal of the Experimental Analysis of Behavior*, 13, 243-266.
- Hughes, C. E., & Branch, M. N. (1991). Tolerance to and residual effects of cocaine in squirrel monkeys depend on reinforcement-schedule parameter. *Journal of the Experimental Analysis of Behavior*, 56, 345-360.
- Igaki, T., & Sakagami, T. (2004). Resistance to change in goldfish. *Behavioral Processes*, 66, 139-152.

- Laraway, S., Snycerski, S., Michael, J., & Poling, A. (2003). Motivating operations and terms to describe them: Some further refinements. *Journal of Applied Behavior Analysis*, 36, 407-414.
- Lerman, D. C., Iwata, B. A., & Wallace, M. D. (1999). Side effects of extinction: Prevalence of bursting and aggression during the treatment of self-injurious behavior. *Journal of Applied Behavior Analysis*, 32, 1-8.
- Lerman, D. C., Kelley, M. E., Vorndran, C. M., Kuhn, S. A. C., & LaRue, R. H. (2002). Reinforcement magnitude and responding during treatment with differential reinforcement. *Journal of Applied Behavior Analysis*, 35, 29-48.
- Mace, F. C., Lalli, J. S., Shea, M. C., Pinter Lalli, E., West, B. J., Roberts, M., & Nevin, J. A. (1990). The momentum of human behavior in a natural setting. *Journal of the Experimental Analysis of Behavior*, 54, 163-172.
- Mace, F. C., McComas, J. J., Mauro, B. C., Progar, P. R., Taylor, B., Ervin, R., & Zangrillo, A. N. (2010). Differential reinforcement of alternative behavior increases resistance to extinction: Clinical demonstration, animal modeling, and clinical test of one solution. *Journal of the Experimental Analysis of Behavior*, 93, 349-367.
- Mackintosh, N. J. (1974). *The psychology of animal learning*. London: Academic Press.
- McDowell, J. J. (1988). Matching theory in natural human environments. *The Behavior Analyst*, 11, 95-109.
- Michael, J. L. (1995). What every student of behavior analysis ought to learn: A system for classifying the multiple effects of behavioral variables. *The Behavior Analyst*, 18, 273-284.
- Michael, J. L. (2004). *Concepts and principles of applied behavior analysis*. Kalamazoo, MI: The Association for Behavior Analysis.

- Nevin, J. A. (1974). Response strength in multiple schedules. *Journal of the Experimental Analysis of Behavior*, 21, 389-401.
- Nevin, J. A. (1984). Pavlovian determiners of behavioral momentum. *Animal Learning and Behavior*, 12, 363-370.
- Nevin, J. A. (1995). Contingencies of reinforcement and behavioral momentum: Research and application. *Mexican Journal of Behavior Analysis*, 21, 107-122.
- Nevin, J. A., & Grace, R. C. (2000). Behavioral momentum and the law of effect. *Behavioral and Brain Sciences*, 23, 73-130.
- Nevin, J. A., & Grace, R. C. (2005). Resistance to extinction in the steady state and in transition. *Journal of Experimental Psychology: Animal Behavior Processes*, 31, 199-212.
- Nevin, J. A., Grace, R. C., Holland, S., & McLean, A. P. (2001). Variable-ratio versus variable-interval schedules: Response rate, resistance to change, and preference. *Journal of the Experimental Analysis of Behavior*, 76, 43-7.
- Nevin, J. A., Mandell, C., & Atak, J. R. (1983). The analysis of behavioral momentum. *Journal of the Experimental Analysis of Behavior*, 39, 49-59.
- Nevin, J. A., McLean, A. P., & Grace, R. C. (2001). Resistance to extinction: Contingency termination and generalization decrement. *Animal Learning and Behavior*, 29, 176-191.
- Nevin, J. A., Tota, M. E., Torquato, R. D., & Shull, R. L. (1990). Alternative reinforcement increases resistance to change: Pavlovian or operant contingencies. *Journal of the Experimental Analysis of Behavior*, 53, 359-379.
- Podlesnik, C. A., & Shahan, T. A. (2008). Response-reinforcer relations and resistance to change. *Behavioural Processes*, 77, 109-125.
- Podlesnik, C. A., & Shahan, T. A. (2009). Behavioral momentum and relapse of extinguished operant responding. *Learning & Behavior*, 37, 357-364.

- Poling, A., & Normand, M. (1999). Noncontingent reinforcement: An inappropriate description of time-based schedules that reduce behavior. *Journal of Applied Behavior Analysis*, 32, 237-238.
- Rachlin, H., & Baum, W. M. (1972). Effects of alternative reinforcement: Does the source matter? *Journal of the Experimental Analysis of Behavior*, 18, 231-241.
- Skinner, B. F. (1938). *The behavior of organisms*. Acton, MA: Copley Publishing Group.
- Skinner, B. F. (1953). *Science and human behavior*. New York, NY: The Free Press.
- Skinner, B. F. (1957). *Verbal behavior*. Acton, MA: Copley Publishing Group.
- Sparrow, Cicchetti, & Balla (2005). *The vineland adaptive behavior scale, VABS-II* (2nd ed.) [administration and scoring manual]. Minneapolis, MN: NCS Pearson.
- Steinhilber, J., & Johnson, C. (2007). The effects of brief and extended stimulus availability on preference. *Journal of Applied Behavior Analysis*, 40, 767-772.
- Tonneau, F., Ríos, A., & Cabrera, F. (2006). Measuring resistance to change at the within-session level. *Journal of the Experimental Analysis of Behavior*, 86, 109-121.
- Tota-Faucette, M. E. (1991). *Alternative reinforcement and resistance to change* (Unpublished doctoral dissertation). University of North Carolina at Greensboro.
- Vollmer, T. R. (1999). Noncontingent reinforcement: Some additional comments. *Journal of Applied Behavior Analysis*, 32, 239-240.
- Vollmer, T. R., & Hackenberg, T. D. (2001). Reinforcement contingencies and social reinforcement: Some reciprocal relations between basic and applied research. *Journal of Applied Behavior Analysis*, 34, 241-253.
- Wechsler, D. (2002). *The Wechsler preschool and primary scale of intelligence, WPPSI-III* (3rd ed.) [administration and scoring manual]. Manual, TX: Harcourt Assessment.

Wiig, E. H., Second, W. A., & Semel, E. (2004). *The clinical evaluation of language fundamentals, CELF 2* (2nd ed.) [administration and scoring manual]. San Antonio, TX: Pearson Education.

APPENDICES

Appendix A

Preference Assessment Data Sheet

Paired-Stimulus Preference Assessment

Data collector: _____ (circle one) Primary Secondary

Participant: _____ Date: _____

Stimuli

1		3		5		7	
2		4		6		8	

Circle participant's response, circle both items if dual selected, or check box if "no response" (NR)

Trial	Left	Right	NR	Correct arrangement Y/N
1	1	2		
2	3	4		
3	5	6		
4	7	8		
5	2	3		
6	4	5		
7	8	2		
8	6	7		
9	3	1		
10	4	2		
11	7	5		
12	8	6		
13	5	3		
14	8	1		
15	6	4		
16	4	1		
17	2	5		
18	3	6		
19	4	7		
20	5	8		
21	1	5		
22	2	6		
23	3	7		
24	8	4		
25	6	1		
26	7	2		
27	8	3		
28	7	1		

Trial	Left	Right	NR	Correct arrangement Y/N
29	2	1		
30	4	3		
31	6	5		
32	8	7		
33	3	2		
34	5	4		
35	2	8		
36	7	6		
37	1	3		
38	2	4		
39	5	7		
40	6	8		
41	3	5		
42	1	8		
43	4	6		
44	1	4		
45	5	2		
46	6	3		
47	7	4		
48	8	5		
49	5	1		
50	6	2		
51	7	3		
52	4	8		
53	1	6		
54	2	7		
55	3	8		
56	1	7		

Summary (enter number of times selected out of 14 opportunities)

1		3		5		7	
2		4		6		8	

Appendix B

Data Sheet for Behavioral Momentum Experimental Sessions

Behavioral Momentum Comparison

Data collector: _____ (circle one) Primary Secondary

Participant: _____ Date: _____

Phase: Baseline Intervention Disruption Reinstatement Session # _____

Context: Therapist 1/Lean Therapist 2/Rich

Number of target responses		Response Tally	
Session duration (total _____, consumption _____)		Response rate	

Number of reinforcers delivered on VI schedule		Reinforcer Tally	
Number of Reinforcers delivered on VT schedule			
Total number of reinforcers delivered		Rate of reinforcement	

Treatment Integrity*Per opportunity**Partial interval (10 s bins)*

	Correct S ^R delivery			Correct S ^R delivery	
	VI	VT		VI	VT
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		

7			25		
8			26		
9			27		
10			28		
11			29		
12			30		

13			31		
14			32		
15			33		
16			34		
17			35		
18			36		

SUM.

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	Verbal attention + correct - incorrect	Physical attention		Verbal attention + correct - incorrect	Physical attention
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		

7			25		
8			26		
9			27		
10			28		
11			29		
12			30		

13		
14		
15		
16		
17		
18		

SUM.

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Appendix C

Data Sheet for Daily Session Tracking

Daily data collection sheet

Date _____

Participant _____

Condition	Session # _____ Therapist _____	Session # _____ Therapist _____
	Context (<i>circle one</i>) Rich Lean	Context (<i>circle one</i>) Rich Lean
	Response tally	Response tally
	<i>Total</i> _____	<i>Total</i> _____
	Reinforcement tally	Reinforcement tally
	<i>Total</i> _____	<i>Total</i> _____

Condition	Session # _____	Session # _____
	Response tally	Response tally
	<i>Total</i> _____	<i>Total</i> _____
	Reinforcement tally	Reinforcement tally
	<i>Total</i> _____	<i>Total</i> _____

Condition	Session # _____	Session # _____
	Response tally	Response tally
	<i>Total</i> _____	<i>Total</i> _____
	Reinforcement tally	Reinforcement tally
	<i>Total</i> _____	<i>Total</i> _____

Condition	Session # _____	Session # _____
	Response tally	Response tally
	<i>Total</i> _____	<i>Total</i> _____
	Reinforcement tally	Reinforcement tally
	<i>Total</i> _____	<i>Total</i> _____

Appendix D

Data Sheet for Session Tracking Across Days, Form A

Participant _____

FORM A

Therapist 1 (LEAN) _____

VI Schedule _____

Therapist 2 (RICH) _____

VT Schedule _____

Conditions
reinstatementBL = *baseline*Int = *Intervention*Dis = *Disruption*

Re =

Date	Rich	Lean	Rich	Lean	Rich	Lean	Rich	Lean
Condition								
Session #								
Response rate								
Reinforcer rate								

Date	Lean	Rich	Lean	Rich	Lean	Rich	Lean	Rich
Condition								
Session #								
Response rate								
Reinforcer rate								

Date	Rich	Lean	Rich	Lean	Rich	Lean	Rich	Lean
Condition								
Session #								
Response rate								
Reinforcer rate								

Date	Lean	Rich	Lean	Rich	Lean	Rich	Lean	Rich
Condition								
Session #								
Response rate								
Reinforcer rate								

Date	Rich	Lean	Rich	Lean	Rich	Lean	Rich	Lean
Condition								
Session #								
Response rate								
Reinforcer rate								

Date	Lean	Rich	Lean	Rich	Lean	Rich	Lean	Rich
Condition								
Session #								
Response rate								
Reinforcer rate								

Appendix E

Data Sheet for Session Tracking and Counterbalancing Across Days, Form B

Participant _____

FORM B

Therapist 1 (LEAN) _____

VI Schedule _____

Therapist 2 (RICH) _____

VT Schedule _____

Conditions BL = *baseline* Int = *Intervention* Dis = *Disruption* Re = *reinstatement*

Date	Lean	Rich	Lean	Rich	Lean	Rich	Lean	Rich
Condition								
Session #								
Response rate								
Reinforcer rate								

Date	Rich	Lean	Rich	Lean	Rich	Lean	Rich	Lean
Condition								
Session #								
Response rate								
Reinforcer rate								

Date	Lean	Rich	Lean	Rich	Lean	Rich	Lean	Rich
Condition								
Session #								
Response rate								
Reinforcer rate								

Date	Rich	Lean	Rich	Lean	Rich	Lean	Rich	Lean
Condition								
Session #								
Response rate								
Reinforcer rate								

Date	Lean	Rich	Lean	Rich	Lean	Rich	Lean	Rich
Condition								
Session #								
Response rate								
Reinforcer rate								

Date	Rich	Lean	Rich	Lean	Rich	Lean	Rich	Lean
Condition								
Session #								
Response rate								
Reinforcer rate								

CURRICULUM VITAE

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Education

- 2010 (anticipated) Doctor of Philosophy in Disability Disciplines,
Applied Behavior Analysis Specialization
Utah State University, Logan, UT
Dissertation: Examination of Behavioral Momentum with Staff as
Contextual Variables in Applied Settings with Children with
Autism
Advisor: Timothy A. Slocum
- 2004 Advanced Training Program
(Post-master's program in Applied Behavior Analysis)
Northeastern University, Boston, MA
- 2004 Master of Science in Education
Simmons College, Boston, MA
- 2000 Bachelor of Science in Psychology, Premed
University of Utah, Salt Lake City, UT

Professional Certifications

- 2005 Board Certified Behavior Analyst (BCBA™)

Peer Reviewed Publications

- Groskreutz, M.P., Groskreutz, N. C., & Higbee, T. S. (in press).
Response Competition and Stimulus Preference in the Treatment of
Automatically Reinforced Behavior: A Comparison. *Journal of Applied
Behavior Analysis*.
- Groskreutz, N. C., Karsina, A., Miguel, C. F., & Groskreutz, M. P.
(2010). *Using complex auditory-visual samples to produce emergent
relations in children with autism*. *Journal of Applied Behavior Analysis*,
43, 131-136.
- Groskreutz, M. P. & Graff, R. B. (2009). Evaluating pictorial preference
assessment: The effect of differential outcomes on preference assessment
results. *Research in Autism Spectrum Disorders*, 3, 113-128.

Manuscripts in Preparation

- Groskreutz, M. P., Groskreutz, N. C., Peters, A. & Higbee, T. S. (2010).
Teaching children with autism spectrum disorders to make naturally cued
social comments during play activities. (*manuscript in preparation*).
- Groskreutz, M. P., Groskreutz, N. C., Wintle, P. & Higbee, T. S. (2010).
Comparison of time delay and spatially faded prompts in preschoolers
with autism. (*manuscript in preparation*).

Groskreutz, N. C., Groskreutz, M. P., & Higbee, T. S. (2010). Effects of varying levels of treatment integrity on appropriate toy manipulation in children with autism. (*manuscript in preparation*).

Groskreutz, M. P. & Lignugaris/Kraft, B. (2010). Evaluation of stimulus preference assessment as an evidence based practice for students with moderate to severe developmental disabilities. (*manuscript in preparation*).

Other Publications

Groskreutz, M. P. (2009). Measuring progress and ongoing assessment: What we need to know before we know what works. *The Utah Special Educator*, 31 (4), 18-19.

Groskreutz, M. P. (2008). "How can we help you learn?" It's much more than just M&Ms: Autism, learning, and applied behavior analysis. *Technical Assistance for Excellence in Special Education (TAESE)*, 11 (2), 13-14.

Groskreutz, M. P. (2008). It's much more than just M&Ms: Learning, autism, and applied behavior analysis. *The Utah Special Educator*, 28 (3), 22-23.

Ongoing Research

Groskreutz, N. C., Bloom, S. E., Groskreutz, M. P., & Slocum, T. A. Generalization of negatively-reinforced mands in children with developmental disabilities.

Groskreutz, M. P., Groskreutz, N. C., & Collins, S. Comparison of procedures and measures during functional analyses.

Invited Presentations

Groskreutz, M. P. (2009, June). *ABA, autism, and learning*. Invited presentation on assessment and intervention for students with autism delivered to the Wasatch Front Special Education Directors. Heber City, UT.

Groskreutz, M. P. (2009, June). *Prompting for independence: Pitfalls and promises*. Invited presentation at the Effective Practices Conference, Utah State University. Logan, UT.

Groskreutz, M. P. (2008, June). *Independence and the importance of prompting*. Invited presentation at the Effective Practices Conference, Utah State University. Logan, UT.

Groskreutz, M. P. (2008, February). *Learning, autism, and ABA: Finding what works*. Invited presentation at the Utah Personnel Development Centers's (UPDC) Autism/Asperger Educator Conference. Ogden, UT.

Professional Presentations

Groskreutz, M. P., Slocum, T. A., & Groskreutz, N. C., (2010, May). A Translational Study Examining Behavioral Momentum and Context in Children with Autism. Symposium at the 36th Annual Association for Behavior Analysis International Convention. San Antonio, TX.

Groskreutz, M. P., Groskreutz, N. C., & Higbee, T. S. (2009, May). *Application of script-fading procedures to teach naturally cued social comments during play activities*. Symposium at the 35th Annual Association for Behavior Analysis Convention. Phoenix, AZ.

Groskreutz, M. P., Groskreutz, N. C., & Higbee, T. S. (2009, March). *Teaching children with autism spectrum disorders to make naturally cued social comments during play activities*. Symposium at the California Association for Behavior Analysis (Cal ABA), 27th Annual Western Regional Conference on Behavior Analysis. Burlingame, CA.

Groskreutz, M. P., Chair (2008, May). *Further evaluation of interventions using response-independent/noncontingent schedules of reinforcement*, Symposium at the 34th Annual Association for Behavior Analysis Convention. Chicago, IL.

Groskreutz, M. P. (2005, October). *The effects of intermittent access to stimuli on pictorial preference assessment outcomes*. Symposium at the 26th Annual Berkshire Association for Behavior Analysts and Therapists (BABAT) Conference. Amherst, MA.

Groskreutz, M. P., Graff, R. B., Collins, K., & Chappell, N. A. (2005, May). *The effect of differential consequences on preference assessment outcomes*. Symposium at the 31st Annual Association for Behavior Analysis Convention. Chicago, IL.

Groskreutz, M. P., Graff, R. B., Collins, K., & Chappell, N. A. (2004, October). *Further evaluation of pictorial preference assessments*. Symposium at the 25th Annual Berkshire Association for Behavior Analysts and Therapists (BABAT) Conference. Amherst, MA.

Groskreutz, M. P., Graff, R. B., & Collins, K. (2004, May). *Further evaluation of pictorial preference assessments*. Symposium at the 30th Annual Association for Behavior Analysis Convention. Boston, MA.

Groskreutz, M. P., & Graff, R. B. (2003, October). *Evaluating tangible and pictorial preference assessments*. Poster at the 24th Annual Berkshire Association for Behavior Analysts and Therapists (BABAT) Conference. Amherst, MA.

Workshops

Groskreutz, M. P., Peters, A., Wintle, P., & Higbee, T. S. (2008, July). *Helping learners with autism and other developmental disabilities succeed*. Four-day workshop presented to special educators and related professionals in Weber School District, Ogden, UT.

Groskreutz, M. P., Higbee, T. S., & Peters, A. (2007, July). *Incorporating an ABA perspective on learning into collaboration with and supervision of special educators throughout the district*. One-day workshop presented to Special Education Coordinators in Weber School District, Ogden, UT.

Groskreutz, M. P., Peters, A., Wintle, P., & Higbee, T. S. (2007, July). *ABA-based program design in High/Scope preschool classrooms for students with developmental disabilities*. Three-day workshop presented to High/Scope preschool teachers and para-professionals in Weber School District, Ogden, UT.

Co-Authored Presentations

Groskreutz, N. G., Groskreutz, M. G., & Higbee, T. S. (2009, March). *A comparison of temporally and spatially faded prompting procedures for children with autism spectrum disorders*. Symposium at the California Association for Behavior Analysis (Cal ABA), 27th Annual Western Regional Conference on Behavior Analysis. Burlingame, CA.

Groskreutz, N. G., Groskreutz, M. G., & Higbee, T. S. (2008, May). *Effects of varying levels of treatment integrity on appropriate toy manipulation in children with autism*. Symposium at the 34th Annual Association for Behavior Analysis International Convention. Chicago, IL.

Groskreutz, N. G., Higbee, T. S., & Groskreutz, M. G. (2008, February). *An analysis of various levels of treatment integrity on interventions to increase play skills in young children with autism*. Symposium at the California Association for Behavior Analysis (Cal ABA), 26th Annual Western Regional Conference on Behavior Analysis. Garden Grove, CA.

Groskreutz, N. G., Karsina, A. J., Miguel, C., & Groskreutz, M. P. (2005, October). *Using compound auditory-visual samples to increase learning efficiency within match-to-sample trials*. Symposium at the 26th Annual Berkshire Association for Behavior Analysts and Therapists (BABAT) Conference. Amherst, MA.

Lipcon, A., Groskreutz, M. P., & Graff, R. B. (2005, October). *Further evaluation of pictorial preference assessments: With and without access*. Poster at the 26th Annual Berkshire Association for Behavior Analysts and Therapists (BABAT) Conference. Amherst, MA.

Teaching Experience

2008-2009

Behavior Analysis Consultation Specialist and Trainer Weber School District

Utah State University, Logan, Utah

Proposed, designed, and directed 8-month intensive training program in behavior analysis for 5 professionals in Weber School District. Trainees participate for 6-8 hours per day, 1 day per week, including didactic, simulated, and in vivo activities. Developed core curriculum including principles of ABA, ABA-based assessment and intervention, and strategies for effective consultation. Focus on assessment and curriculum for students with autism or other developmental disabilities.

2008 **On Campus and Distance Teaching Assistant – Lead Instructor**
 Advanced Behavior Analysis in Education, SPED 6720
 Utah State University, Logan, UT
 Managed all teaching, course preparation, grading, and course website development responsibilities. Course included classroom on site and 4 distance locations in classrooms throughout Utah.

2007 **On Campus and Distance Teaching Assistant**
 Advanced Behavior Analysis in Education, SPED 6720
 Utah State University, Logan, UT
 Assisted in teaching, course preparation, and grading responsibilities. Course included classroom on site and 5 distance locations in classrooms throughout Utah.

Academic Appointments

2009 **University Graduate Supervisor**
 Utah State University, Logan, UT
 Co-supervised master's degree student in conducting thesis in public school setting with students with disabilities.

2009 **University Undergraduate Supervisor**
 Utah State University, Logan, UT
 Co-supervised undergraduate in special education during student teaching experience, with focus on classroom teaching observations and preparation of student portfolio.

2006 **Personalized System of Instruction Developer**
 Northeastern University – NECC Extension, Boston, MA
 Developed a personalized system of instruction (PSI) for students working towards their Master of Science in Applied Behavior Analysis. PSI was designed to increase the verbal fluency in relation to the methods and principles of applied behavior analysis (ABA).

2006 **Simmons College Writing and Educational Support Provider**
 Simmons College – NECC Extension, Boston, MA
 Supported master's level students in development of successful graduate level writing, studying, and organizational techniques in conjunction with their master's degree coursework in special education

2005-2006 **Supervising Practitioner**
 Simmons College, Boston, MA
 Supported and monitored two master's degree students in completing their 2-semester practicum experience culminating in Massachusetts teacher licensure.

2004-2005 **Teaching Assistant**
 Northeastern University, Boston, MA

Professional Service 2010-present

Educational and Behavioral Consultant
Weber School District
 Weber School District, Ogden, UT
 Consulted to Weber School District to increase the success of students receiving special education services in Weber School District.

- 2009-present **Applied Behavior Analysis and Autism Services Consultant**
Utah State Office of Education and Utah Personnel Development Center
 Salt Lake City, UT
 Collaborated with other professionals to develop initial statewide determination of educational and behavioral needs for placement of students with autism spectrum disorders in intensive ABA-based services
- 2006-2009 **Educational and Behavioral Consultant**
Partners for Success, Weber School District
ABA-based demonstration classroom for children with ASD
 Utah State University, Logan, UT
 Consulted to Weber School District to facilitate increased success for children with autism across educational, behavioral, and family needs.
- 2006-2008 **Supervisor and Case Manager**
Autism Support Services: Education, Research, and Training (ASSERT)
 Utah State University, Logan, UT
 Developed and supervised behavioral and educational programs for preschoolers with autism. Provide supervision, training, and support to aides working with 8 preschoolers with autism.
- Professional Experience**
- 2004-2006 **Program Specialist, Residential Program**
 The New England Center for Children, Southborough, MA
 Developed and supervised behavioral and educational interventions for individuals with severe developmental disabilities in a residential school setting. Conducted behavioral assessments, wrote IEPs, and developed curriculum. Trained and supervised team of 20 teachers in consistent implementation of behavioral guidelines, educational programs, and data collection.
- 2002-2004 **Day Coordinator, Residential Program**
 The New England Center for Children, Southborough, MA
 Coordinated daily staff and student activities. Monitored and maintained instructional programs in accordance with student's IEPs.
- 2001-2002 **Case Manager, Staff Intensive Unit**
 The New England Center for Children, Southborough, MA
 Wrote quarterly progress reports and clinical case reviews evaluating student progress. Communicated weekly with student's family regarding current performance and concerns.
- 2000-2001 **Level 2 Teacher, Staff intensive Unit**
 The New England Center for Children, Southborough MA
 Taught students using the techniques of Applied Behavior Analysis under the supervision of a Board Certified Behavior Analyst.

Editorial / Reviews

- 2010 Guest Reviewer – 6/10
Education and Treatment of Children
- 2009 Conference Submission Reviewer – 2/09
Council for Exceptional Children (CEC)
- 2009 Guest Reviewer – 6/09
Education and Treatment of Children
- 2007 Guest Reviewer – 10/07
The Psychological Record
- 2007 Guest Reviewer – 11/07
Journal of Applied Behavior Analysis

Grant Experience

- Agency: U.S. Department of Health and Human Services, Health Resources and Services Administration
- Role: Graduate Assistant
- Purpose: The purpose of this program is to improve access to comprehensive, coordinated health care and related services for children and youth with autism spectrum disorder (ASD) and other developmental disabilities.
- Proposed Duration: 3 years (9/2008 – 8/2011)
- Amount: \$300,000 per year (funded)

Internships and Supervised Practicum

- 2004-2005 Mentoring Program for Teachers with initial certification
The New England Center for Children, Southborough, MA
Collaborated with a senior certified teacher and program director in professional development with the goal of professional licensure.
Supervisor: Kim Keogh, MEd, BCBA™
- 2004 Special Education Practicum Experience
Simmons College, Boston, MA
The New England Center for Children, Southborough, MA
Developed and presented educational lessons for both integrated preschool students with and without ASDs and adolescent students with severe disabilities and ASDs.
Supervisors: Lisa Williams, MEd, Chris Evans, MEd

Professional Organization Membership

- 2004-Present Association for Behavior Analysis International (ABAI)
- 2007-Present California Association for Behavior Analysis (CalABA)
- 2008-Present Association of Professional Behavior Analysts (APBA)
- 2008-Present Four Corners Association for Behavior Analysis

Institutional Service

- 2006-present Attendee, T. Shahan – A. Odum Research Lab
Experimental Analysis of Behavior
Department of Psychology
Utah State University, Logan, UT

2006-2009	Attendee, T. Higbee Research Lab Applied Behavior Analysis Department of Special Education and Rehabilitation, Utah State University, Logan, UT
2005-2006	Member, Stimulus Control Lab The New England Center for Children, Southborough, MA
2004-2006	Member, Peer Review Group The New England Center for Children, Southborough, MA
2004-2006	Member, Research Development Group The New England Center for Children, Southborough, MA
2002-2006	Member, Training Group The New England Center for Children, Southborough, MA

Honors

2006-2007	Vice-Presidential Research Fellowship Utah State University, Logan, UT
2004-2005	Jonathon Levin Memorial Scholarship and Professional Award Foundation for Educating Children with Autism, Mt. Kisco, NY <i>Awarded to individuals committed to the profession of education, with an emphasis on working with students with autism, while utilizing the techniques of Applied Behavior Analysis.</i>
2003	Friends and Family Award for Research Contribution, The New England Center for Children, Southborough, MA <i>"Awarded to individuals in graduate school who show potential as future researchers."</i>
1998-2000	Henry J. Reilly Memorial Scholarship, (1998-1999, 1999-2000)
1996-2000	University of Utah President's Award
1996-2000	Dean's list, University of Utah